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# SELECTED WATER RESOURCES ABSTRACTS



VOLUME 4, NUMBER 7  
APRIL 1, 1971

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# SELECTED WATER RESOURCES ABSTRACTS

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Office of Water Resources Research, U.S. Department of the Interior

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W71-03301 -- W71-03850

As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States—now and in the future.

## FOREWORD

**Selected Water Resources Abstracts**, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifiers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

WRSIC IS NOT PRESENTLY IN A POSITION TO PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

**Selected Water Resources Abstracts** is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by co-ordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas.

Additional "centers of competence" have been established in cooperation with the Environmental Protection Agency. A directory of the Centers appears on inside back cover.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangements of this bulletin are welcome.

Water Resources Scientific Information Center  
Office of Water Resources Research  
U.S. Department of the Interior  
Washington, D. C. 20240



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# SELECTED WATER RESOURCES ABSTRACTS

## 01. NATURE OF WATER

### 1A. Properties

VACUUM UV ABSORPTION SPECTRA OF LIQUID WATER AND ICE,  
For primary bibliographic entry see Field 02K.  
W71-03431

### 1B. Aqueous Solutions and Suspensions

SOLUBILITY AND DISSOLUTION RATE OF AMORPHOUS SILICA IN DISTILLED AND SEA WATER AT 20 DEG C,  
Nagoya Univ. (Japan). Water Research Lab.  
For primary bibliographic entry see Field 02K.  
W71-03436

## 02. WATER CYCLE

### 2A. General

PRESENT HYDROLOGIC RESEARCH IN WYOMING AND FUTURE NEEDS.  
Wyoming Univ., Laramie. Water Resources Research Inst.

Available from NTIS as PB-196 661, \$3.00 in paper copy, \$0.95 in microfiche. Wyoming Water Resources Research Institute, Miscellaneous publication (1970). Proceedings of Hydrology Seminary at University of Wyoming, June 25-26, 1970. OWRR Program A-999-WYO (10).

Descriptors: \*Planning, \*Hydrology, Research, \*Wyoming, Runoff, Streamflow, \*Surface waters, Watersheds (Basins), Forestry, Land Management, Water quality, Soil conservation, Sagebrush, Snowmelt, \*Snow management, Snowpacks, Agricultural engineering, Economics.  
Identifiers: Bighorn National Forest, Medicine Bow National Forest.

Contents: Wyoming Water Resources Research Institute, by Louis E. Allen; The Hydrology of Sagebrush Lands and the Management of Blowing Snow, by Ronald D. Tabler; Soil Conservation Service Hydrology and Research Needs in Wyoming, by Lynn A. Brown; Hydrologic Activities of the Agricultural Engineering Division, by Robert D. Burman; Hydrology in the Wyoming Water Planning Program, by Doyl M. Fritz, Peter J. Hutchison and Frank J. Trelease; Water Quality, by Robert L. Champlin; Present Hydrology Programs on the Bighorn National Forest, by Robert E. Lynn; A Manual For Forecasting Snowmelt Runoff, by George W. Peak; Snow Crystal Type as a Function of Vapor Density Excess, by Don Rottner; Present Hydrologic Research and Future Needs in Wyoming, by Jesse L. Honnold; Hydrology and the Wyoming Department of Economic Planning and Development, by Theodore J. Vore; Encampment Barometer Watershed Program - Medicine Bow National Forest, by R. L. Beschta; and Hydrologist and Hydrology - Interpretive Assistance to the District Forest Ranger, by R. S. Aygarn.  
W71-03306

GEOMORPHOLOGY AT THE CENTRAL ARID ZONE RESEARCH INSTITUTE, INDIA,  
International Inst. for Aerial Survey and Earth Sciences, Delft (Netherlands).  
For primary bibliographic entry see Field 07A.  
W71-03339

MATHEMATICAL SIMULATION OF HYDROLOGIC EVENTS OF UNGAGED WATERSHEDS,  
Purdue Univ., Lafayette, Ind. Water Resources Research Center.  
L. F. Huggins, and E. J. Monke.

Available from NTIS as PB-196 874, \$3.00 in paper copy, \$0.95 in microfiche. Purdue University Water Resources Research Center Technical Report No 14, Lafayette, Indiana, Dept. of Agricultural Engineering, March 1970. 46 p, 9 fig, 20 ref, append. OWRR Program B-003-IND (8).

Descriptors: \*Model studies, \*Hydrologic models, \*Simulation, Mathematical models, \*Watershed, Surface runoff, Overland flow, Depression storage, Interception, Infiltration, Runoff hydrographs.  
Identifiers: Hydrologic components.

General modeling concepts and the computational capabilities of a large digital computer was utilized to describe the detailed physical processes occurring within the boundaries of a watershed which in turn could then more precisely characterize the behavior of an entire watershed. It was assumed that a watershed was composed of a composite group of essentially independent elements and that the runoff water from one element was the source of inflow to its adjacent elements. Runoff hydrographs for each elemental area were developed and integrated over the entire watershed. Physical process considered in the model included interception, infiltration, depressional storage and surface flow. A FORTRAN IV program of the mathematical watershed model is included in the report. The model as given is not considered to be in the finished form, but a refinement of the equations governing the component hydrologic relationships is still needed. This applied particularly to the infiltration and surface runoff processes. A primary conclusion was that the strength of the conceptual watershed model as developed was the ease with which it could be modified and improved as individual research advances were made in the areas associated with the various hydrologic components delineated in the model. (Wiersma-Purdue)  
W71-03520

### DEFINITION AND USES OF THE LINEAR REGRESSION MODEL

Agricultural Research Service, Tucson, Ariz. Southwest Watershed Research Center.

M. H. Diskin.

Water Resources Research, Vol 6, No 6, p 1668-1673, December 1970. 6 p, 4 fig, 2 tab, 11 ref.

Descriptors: \*Regression analysis, \*Rainfall-runoff relationships, \*Statistical models, Precipitation (Atmospheric), Streamflow forecasting, Runoff forecasting, Water storage, Seasonal.  
Identifiers: \*Rainfall-runoff models.

A simple three-element model is proposed as an interpretation of the regression equation for the relationship between annual rainfall and annual runoff from watersheds. The model employs two parameters that are related to the constants used in the regression equation. The parameters of the model can be evaluated by the usual least squares equations if the runoff data do not include zero or near zero values. For arid or semiarid watersheds where runoff may be zero for some years, a special procedure is proposed for evaluating the parameters. The procedure seeks the minimum of an objective function defined as the sum of squared deviations between observed data and prediction lines defined by the regression model. (Knapp-USGS)  
W71-03682

### FLOOD SERIES COMPARED TO RAINFALL EXTREMES

Pennsylvania State Univ., University Park.  
For primary bibliographic entry see Field 02E.  
W71-03685

POSSIBLE EFFECTS OF PRECIPITATION MODIFICATION ON STREAM CHANNEL GEOMETRY AND SEDIMENT YIELD,  
Pennsylvania State Univ., University Park.  
For primary bibliographic entry see Field 03B.  
W71-03693

SOME GENERAL COMMENTS ON THE SYNERGISTIC RUNOFF EFFECT FROM JOINT WATERSHED MANAGEMENT AND WEATHER MODIFICATION,  
State Univ. of New York, Syracuse. Water Resources Center.  
Richard H. Hawkins.

Journal of Hydrology, Vol 11, No 4, p 412-420, November 1970. 9 p, 2 fig, 9 ref.

Descriptors: \*Weather modification, \*Water yield improvement, \*Watershed management, \*Mathematical models, Water yield, Artificial precipitation, Cloud seeding, Rainfall-runoff relationships, Evapotranspiration control.  
Identifiers: \*Synergistic effects, \*Watershed management effects.

The synergistic effect in combined watershed and weather modification efforts is discussed and explored in general terms. Using an annual precipitation-runoff model, it is demonstrated that synergism is an expected phenomenon in models under most conditions and assumptions. An expression for locating the precipitation corresponding to the maximum synergism is presented. Two separate functional models are used to illustrate the use of the general relationships derived, and specific data are used to provide perspective and scale. Expressions for the weather modification efficiencies are presented and discussed. The volumes of the synergistic increases, as drawn from a real example, are quite modest, (about 0.05 inches), and might be undetectable in a real situation. (Knapp-USGS)  
W71-03696

### THE GENETIC METHOD OF COMPUTATION OF FLOOD CAUSED BY STORM RAINFALLS IN SMALL CATCHMENT AREAS IN THE ABSENCE OF HYDROLOGICAL DATA,

Wyzsza Szkoła Rolnicza, Wrocław (Poland).

J. Woloszyn.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), P 301-312, 1969. 12 p, 6 fig, 1 tab, 9 ref.

Descriptors: \*Rainfall-runoff relationships, \*Depth area-duration analysis, \*Water balance, Statistical methods, Routing, Duration curves, Frequency analysis, Rainfall intensity, Rainfall disposition, Small watersheds, Flood forecasting, Runoff forecasting.  
Identifiers: Rainfall floods.

A number of well known regional and universal formulas for runoff from storm rainfall are reviewed with emphasis on the formulas which are drawn from the analysis of the genetic formation of runoff. In these the rate of flow depends on intensity and duration of rainfall as well as on basin characteristics and on wave velocity in the stream profile. However, for computation of runoff of a definite probability of occurrence, the rainfall intensity should be determined following the same principles that are applied for the actual series, that is following the distribution of Pearson's type III curve. The distribution of empirical formulas on a group basis is discussed. The probability method for computation of the rainfall intensity, adaptation of this for computing the flow of high water from small basins, and transposing it to uninvestigated areas by means of the monthly mean precipitation and air temperature are illustrated by diagrams and examples. (Knapp-USGS)  
W71-03716

### METHOD OF COMPUTING RAINFALL FLOODS CHARACTERISTICS,

Kazakhskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Alma-Ata (USSR).

U. B. Vinogradov.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), p 312-320, 1969. 9 p, 1 tab, 1 ref.

## Field 02—WATER CYCLE

### Group 2A—General

Descriptors: \*Flood forecasting, \*Rainfall-runoff relationships, Water balance, Hydrograph analysis, Stochastic processes, Probability, Routing, Infiltration, Hydrologic budget, Frequency analysis.  
Identifiers: Rainfall floods.

The main relationships of infiltration processes, surface and rapid subsurface runoffs, and flood formation are examined. The basic formulas to compute infiltration, runoff, hydrographs of inflow to the channel network and runoff at the outlet are given. The fundamental theory of random functions is applied to analyze the process of precipitation and to compute surface runoff. The statistics of distribution curves of daily totals of precipitation and duration of rainfall are discussed with special attention paid to the composition method of determining the probability characteristics of rainfall floods. The possibility of mapping the parameters of distribution curves of precipitation and of systematizing the physical parameters of drainage basins is illustrated by an example from Central Asia and the South Kazakhstan mountain area. (Knapp-USGS)  
W71-03717

**CONTRIBUTION TO THE METHODOLOGY OF EVALUATION OF MAXIMUM FLOOD FLOW WHEN AVAILABLE DATA ARE INSUFFICIENT (FRENCH)**,  
Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France).

J. Rodier.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), p 283-289, 1969. 7 p, 3 ref.

Descriptors: \*Flood forecasting, \*Rainfall-runoff relationships, Hydrographs, Duration curves, Routing, Stream gages, Hydrologic data, Design flood, Peak discharge.  
Identifiers: Isochrone method.

Methods used in the Hydrological Service of the ORSTOM for rainfall floods in Africa, on islands of the Indian Ocean and in the Pacific, are presented. The management and the study of numerous representative basins led to general methods for determining the elements of the rainfall-runoff relations and for estimating floods on small basins without observational data. It is possible to transfer these methods to other regions provided that some adjustments are made to the rainfall and flood regimes. The relations between the decennial or centennial floods and median floods for large basins in Central Africa are determined. With adjustments for natural conditions they are applied to basins with few records. For medium basins the method of isochrones is used, especially for maximum possible floods and for the case of a cyclonic regime. In this case the envelop curves are used as well. (Knapp-USGS)  
W71-03718

**EXPERIMENTAL STUDY OF RAINFALL RUNOFF**,  
Gidrometeorologicheskii Institut, Odessa (USSR). A. N. Befani, N. F. Befani, E. D. Goptchenko, A. G. Ivanenko, and T. V. Odrova.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), p 274-282, 1969. 9 p, 4 ref.

Descriptors: \*Rainfall-runoff relationships, \*Hydraulic models, \*Computer models, Demonstration watersheds, Simulated rainfall, Infiltration, Runoff, Groundwater movement, Water balance, Hydrologic budget, Routing, Mathematical studies, Drainage, Seepage.  
Identifiers: Runoff models.

Results of long-term experimental research on rainfall-runoff on plain and mountain watersheds situated in different regions of the USSR are discussed. Methods of active experimentation include spring-

king of plots and natural small drainage basins, slope submersion, and pit digging. The results obtained are outlined. Data generalization methods are explained. Experimental formulas determining surface absorption, infiltration into an underlying confining layer on mountain slopes, soil retention of a friable rock layer in mountainous regions, accumulation, residual (contact and general) water storage on slopes, time of travel of surface and contact (drainage and confined) waters and contact and surface components of flood runoff are given. Special attention was paid to data generalization techniques using electronic computers. A comparison of results obtained by using experimental formulas and data of experimental stations is given. Fair agreement between computations and flood data prove the suitability of the experimental method and its useful role in flood studies. (Knapp-USGS)  
W71-03719

#### RAINFALL FLOOD FORMATION THEORY AND METHODS OF RAINFALL FLOOD COMPUTATION,

Gidrometeorologicheskii Institut, Odessa (USSR). A. N. Befani.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), p 259-273, 1969. 15 p, 5 ref.

Descriptors: \*Rainfall-runoff relationships, \*Flood forecasting, Stage-discharge relations, Floods, Flood plains, Runoff, Runoff forecasting, Design flood, Hydraulics, Routing.  
Identifiers: USSR, Rainfall floods.

Fundamentals of the theories used in the USSR of different rainfall runoff types include: suspended surface runoff, comprising the predominant part of the surface inflow of rivers of the plains and a certain part of mountain river runoff; backwater surface runoff from mountain slopes arising as a result of saturation of friable ground; backwater runoff from flooded lowlands; and contact runoff from mountain slopes in friable sediment strata overlying a relatively confining layer (drainage, vein, stratum and fissure runoff). Formulas for runoff depth computation and hydrograph equations are proposed for each type of runoff. For mixed (rainfall and snowmelt) floods theoretical formulas of contact and surface components are elaborated. The problem of derivation on a theoretical basis of design formulas is set and solved as a task of a regional nature, because the nature and genesis of floods vary from one region to another; hence the combinations of factors vary as well. Methods of calculation of regional runoff relationships including formulas of accumulation and reduction of precipitation, typical equations of rainfall graphs, isochron curves, retention, absorption and infiltration formulas, etc. are discussed. Primary attention is paid to the slope water formation (difference of precipitation and simultaneous losses) design problem. Two designs are based on: (1) Obtaining series of water formation on various arable lands using infiltration formulas (synthetic method) and (2) Mapping of the water formation conditional coefficient (the ratio of water formation and precipitation depth of the same frequency). (Knapp-USGS)  
W71-03720

#### THE EFFECT OF RAINFALL ON THE MECHANICS OF STEADY SPATIALLY VARIED SHEET FLOW ON A HYDRAULICALLY SMOOTH BOUNDARY,

Illinois Univ., Urbana. Dept. of Civil Engineering. For primary bibliographic entry see Field 02E.  
W71-03727

## 2B. Precipitation

**THE EFFECT OF RAINDROP IMPACT AND SURFACE ROUGHNESS ON SHEET FLOW**,  
Illinois Univ., Urbana. Water Resources Center.

Harry G. Wenzel.

Available from NTIS as PB-196 664, \$3.00 in paper copy, \$0.95 in microfiche. Final Report, Illinois Water Resources Center, Urbana, WRC Research Report No 34, September 1970. 115 p, 34 fig, 23 ref, append. OWRR Project B-018-ILL (3).

Descriptors: \*Impact (Rainfall), Numerical analysis, \*Raindrops, Resistance, Roughness (Hydraulic), \*Shear stress, \*Sheet flow, Soil erosion, Transition flow, \*Turbulence, Flow, Rainfall, Reynolds number, Sheet erosion.

An experimental and analytical study was conducted to investigate the mechanics of sheet flow as it is affected by rainfall. Water surface profile data were taken in a laboratory flume using artificially generated rainfall and a hydraulically smooth surface. The one-dimensional spatially varied flow equation as developed from the momentum approach was then used to compute the boundary shear stress and subsequently a Weisbach type friction factor. It was found that the results below a Reynolds number of approximately 1000 could be expressed as  $f = C/NR$  where  $C$  increases with increasing rainfall intensity and surface slope. Velocity profile studies show that velocity in the surface region is retarded by the rainfall. Turbulence intensity measurements indicate that turbulence is generated at the surface due to the rainfall and also at the boundary for flow which would normally be laminar without rainfall. Special analysis of the turbulent measurements indicates that the rainfall shifts the turbulent energy to higher frequencies than would be the case without rainfall. Analysis of the flow over rough surfaces taken by the Corps of Engineers shows that rainfall has little effect on resistance beyond the transition region and the transition point may be lowered by the presence of rainfall. A separate study of a single drop striking a stagnant water layer shows that the velocity and pressure field can be computed using a Synthetic-Cell-Fluid scheme to solve the Navier-Stokes equations for this case. A dimensionless maximum impact pressure model was developed and the velocity field and free surface configuration were studied. It was found that surface tension is significant, the diameter of the region of disturbance was approximately one inch, and that locally high shear stress are generated. These stresses could easily cause soil erosion.  
W71-03310

#### TEMPORAL VARIATIONS IN THE NATURE OF ATMOSPHERIC DUST ABOVE AN INTERIOR DESERT BASIN,

Atmospheric Sciences Lab., White Sands Missile Range, N. Mex.

Glenn B. Hoidal, and Abel J. Blanco.  
Archiv Fur Meteorologie, Geophysik und Bioklimatologie, Series A, Vol 19, No 1, p 71-88, 1970. 3 fig, 3 tab, 8 ref.

Descriptors: \*Advection, \*Dusts, \*Spectroscopy, \*Atmospheric physics, \*Topography, Particle size, Precipitation (Atmospheric), Convection, Infrared radiation, Aerosols, New Mexico, Deserts, Arid lands, Great Plains, Silicates, Clays, Carbonates, Absorption, Topography, Meteorology, Aeolian soils, Spectrophotometry, Winds, Air circulation, Cloud physics, Diurnal distribution, Southwest U.S., Variability, Fronts (Atmospheric).  
Identifiers: \*Infrared absorption, \*Exchange layers.

The infrared absorptive properties of giant and large atmospheric dust particles have been little studied. The arid southwestern U.S. has an abundance of loose, unconsolidated soil particles exposed to eolian translocation and various meteorological factors which effect a transport of this mineral-laden dust in high-atmospheric concentrations to other geographical areas which in turn may affect the composition and transmission properties of the atmospheric dusts of those areas. Dust from the tropospheric aerosol was sampled on a 1250 m. peak overlooking the arid Tularosa Basin. The infrared absorption spectrum was deter-

mined and interspectral variations were quantified by the relative intensities of silicate clay and carbonate absorption bands (A/B ratio). A systematic temporal variation of the A/B ratio occurred. The ratio was high during early morning periods of convective activity, precipitation and cold frontal passages from the east and low in the afternoon at times of low convection or precipitation. Apparently, advection of fresh particles from adjacent regions exchange layer caused the low ratio and the high ratio was caused by advected fresh continental particles from the western Great Plains and aged particles from the free atmosphere. (Casey-Arizona)  
W71-03332

#### METEOROLOGICAL DATA AND THE AGRICULTURAL PROBLEM, Connecticut Agricultural Experiment Station, New Haven.

P. E. Waggoner.

Agroclimatological Methods; Proceedings of the Reading Symposium, Natural Resources Research, Vol 7, p 25-38, UNESCO, 1968. 2 fig, 3 tab, 50 ref.

Descriptors: \*Evapotranspiration, \*Precipitation (Atmospheric), \*Climatology, \*Solar radiation, \*Decision making, Arid lands, Droughts, Agriculture, Temperature, Wind velocity, Evaporation, Economic justification, Planning, Vapor pressure, Probability, Probable maximum precipitation, Project planning, Cost-benefit analysis, Forecasting, Statistical methods, Meteorological data.  
Identifiers: \*Agriclimatology, \*Decision matrices, \*Gumbel distribution.

The major importance of agricultural climatology lies in providing information for long-term investment strategies. Operationally, this involves construction of a decision matrix in which planning alternatives and profit data suitable to a given situation entered with meteorological data. If profit expectations between alternatives are different, then action is justified. Useful meteorological data will permit profitability predictions in new projects and will be less useful to traditional agriculture. A suitable weather parameter must therefore be determined, together with useful probabilities, for inclusion in the decision matrix. Drought is the crucial factor in crop growing and is a function of both precipitation and evaporation. Evaporation is focussed upon as the more crucial factor and the Penman method of daily evapotranspiration calculation is described. It is shown that with this criterion, radiation data is most important and humidity and wind speed less important. For a decision matrix, probabilities rather than means are the important climatological figures. When drought indices, precipitation and temperature data were reviewed, it was found that a surprisingly small amount of data from a single station allows an estimate of probabilities. (Casey-Arizona)  
W71-03343

#### DERIVED METEOROLOGICAL DATA: TRANSPERSION, Institut for Land and Water Management Research, Wageningen (Netherlands).

For primary bibliographic entry see Field 02D.

W71-03345

#### WEATHER AND PLANT DISEASE FORECASTING, Weather Bureau, Tifton, Ga. Agricultural Service Office.

For primary bibliographic entry see Field 03F.

W71-03348

#### HURRICANE CAMILLE ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MISSISSIPPI, Geological Survey, Jackson, Miss.

For primary bibliographic entry see Field 07C.

W71-03381

#### THE EFFECT OF WIND ON THE PRECIPITATION DISTRIBUTION OVER A HILLOCK, John Sandsborg.

Nordic Hydrology, Vol 1, No 4, p 235-244, 1970. 10 p, 6 fig, 2 tab, 6 ref.

Descriptors: \*Rain gages, \*Rainfall disposition, \*Distribution patterns, Meteorology, Equipment, Networks, Calibrations, Precipitation gages, Gaging stations.  
Identifiers: Sweden.

Precipitation measurements were made on a hillock during June-November 1959 by means of a very dense network of gages. The precipitation distribution of single rainfall could vary considerably owing to wind conditions. The cause of this phenomenon seems to lie in the aerodynamic conditions around the hillock. When choosing sites for precipitation measurements such aerodynamic effects should be known. The leeward side receives less precipitation than the windward side. This is especially the case for rainfalls in high wind, when the crest of the hillock also has markedly lower precipitation values than the precipitation mean. (Knapp-USGS)  
W71-03395

#### ON ICE NUCLEATING PROPERTIES OF DIFFERENT FACES OF SILVER IODIDE CRYSTALS,

Nagoya Univ. (Japan). Water Research Lab.  
For primary bibliographic entry see Field 03B.  
W71-03430

#### SOLID PRECIPITATION IN SUPER-COOLING CLOUD: PART 1 - FREEZING OF A SUPER-COOL WATER DROP DUE TO THE COLLISION OF ICE CRYSTALS,

Nagoya Univ. (Japan). Water Research Lab.  
Takao Takeda.  
Journal of Meteorological Society of Japan, Series 2, Vol 46, No 1, p 14-28, February 1968. 15 p, 9 fig, 1 tab, 17 ref.

Descriptors: \*Precipitation (Atmospheric), \*Cloud physics, \*Supercooling, \*Condensation, Ice, Nucleation, Atmospheric physics, Statistical methods, Velocity, Clouds, Freezing, Winds, Crystal growth.  
Identifiers: Supercooled clouds.

The freezing-probability of a supercooled water drop, which grows by the capture of cloud droplets due to the collision of ice crystals formed on ice nuclei, was numerically studied in clouds. In all cases, the probability increases about 100 times when the drop is at cloud top, and most of collisions with ice crystals take place when the drop stays near cloud top. The accumulated number of ice crystals colliding with the drop increases with the vertical velocity of air-currents and the height of cloud top. The accumulated number of colliding ice crystals is larger in clouds of small water content than in clouds of large water content, although it tends to increase with the water content in early stage of the growth of the drop. In clouds with tops lower than 3000 m and with velocity of updraft of only a few meter/sec, at most, one drop in 10 to 100 supercooled water drops can collide with one ice crystal in 1.0 to 1.5 hour. (See also W71-03433) (Knapp-USGS)  
W71-03432

#### SOLID PRECIPITATION IN SUPERCOOLED CLOUD: PART 2 - GROWTH OF A SOLID PRECIPITATION PARTICLE,

Nagoya Univ. (Japan). Water Research Lab.  
Takao Takeda.

Journal of Meteorological Society of Japan, Vol 46, No 4, p 255-265, August 28, 1968. 11 p, 6 fig, 1 tab, 16 ref.

Descriptors: \*Precipitation (Atmospheric), \*Cloud physics, \*Supercooling, \*Condensation, Ice, Nucleation, Atmospheric physics, Statistical

methods, Velocity, Clouds, Freezing, Winds, Crystal growth.  
Identifiers: Supercooled clouds.

The growth rates of solid precipitation particles in a supercooled cloud were studied by numerical computations for the case when sublimation and the capture of cloud droplets take place simultaneously. The necessary condition for the predominance of the capture-process in the growth of solid precipitation particles (for the formation of graupel) is that the particle is initially a 'frozen drop' with radius larger than a critical value which is dependent mainly upon the initial height of the particle. The relationship between the computed radii of graupel particles at cloud base and the height of the cloud top is in satisfactory agreement with that obtained from observations. The computed probability that 'frozen drops' of the critical size are formed by nucleation of supercooled water drops in collision with ice crystals is about 10% of that expected from observations. (Knapp-USGS)  
W71-03433

#### THE EFFECTS OF THE TIME LAG IN THE ACTIVATION OF ATMOSPHERIC ICE NUCLEI ON THE NUMBER OF ICE CRYSTALS IN CLOUD,

Nagoya Univ. (Japan). Water Research Lab.  
Takao Takeda.

Journal of Meteorological Society of Japan, Series 2, Vol 46, No 2, p 69-75, April 1968. 7 p, 7 fig, 12 ref.

Descriptors: \*Precipitation (Atmospheric), \*Cloud physics, \*Supercooling, \*Condensation, Ice, Nucleation, Atmospheric physics, Statistical methods, Velocity, Clouds, Freezing, Winds, Crystal growth.  
Identifiers: Supercooled clouds.

The influence of the time lag in the activation of ice nuclei on the number of ice crystals in clouds was numerically studied. The increase in the number of activated atmospheric ice nuclei with cooling-time is remarkable, particularly cooling at lower temperatures than -25 deg C. The total number of atmospheric ice nuclei activated in a few hours under cooling at -30 deg C to -40 deg C is 10 times as large as in 1 minute, while the number of activated at temperatures warmer than -20 deg C is at most 3 times as large. The number of atmospheric ice nuclei activated in upward air-currents with vertical velocities of the order of 10 cm/s is 5 to 10 times as large as in air-currents of the order of 10 m/s. (Knapp-USGS)  
W71-03434

#### AD HOC MEETING ON ACIDITY AND CONCENTRATION OF SULPHATE IN RAIN.

Organization for Economic Co-operation and Development, Paris (France).

Organization for Economic Co-operation and Development, Ex 40119, 1970. 19 p, 1 fig, 7 tab, 2 append.

Descriptors: \*Precipitation (Atmospheric), \*Rain, \*Sulfates, \*Acidity, Meteorology, Air pollution, Monitoring, Water pollution sources, Data collections, Carbonates, Electrical conductance, Conferences.

Identifiers: \*OECD, \*Sulphur dioxide, Sweden, Norway, Finland, Denmark, Iceland, Austria, United Kingdom, Ireland, Germany, Netherlands, Belgium, France.

This 1969 report by the representatives of seven European countries surveys the problem of precipitation, its acidification, and sulphate content. The report is supplemented by a record of pertinent data compiled by Swedish workers in 12 countries of western Europe. Their atmospheric chemistry network detected an overall increase in acidity of precipitation in Scandinavia and central Europe, but not in Great Britain or Ireland. A similar trend was recorded in regard to the concen-

## Field 02—WATER CYCLE

### Group 2B—Precipitation

tration of sulphates. As atmospheric sulphur compounds are transported over long distances, remedial measures require international collaboration. (Wilde-Wisconsin)  
W71-03444

**RADAR MEASUREMENT OF PRECIPITATION RATE,**  
National Science Foundation, Washington, D.C.  
Special Foreign Currency Science Information Program.  
For primary bibliographic entry see Field 07B.  
W71-03527

**PERSISTENCE OF PRECIPITATION AT 108 CITIES IN THE CONTERMINOUS UNITED STATES,**  
Weather Bureau, Silver Spring, Md.  
Donald L. Jorgensen, and William H. Klein.  
Environmental Sciences Service Administration Technical Memorandum WBTM TDL 31, May 1970. 84 p, 6 fig, 3 tab, 14 ref, 2 append.

Descriptors: \*Precipitation (Atmospheric), \*Weather data, \*Meteorological data, Data collections, Probability, Weather forecasting, Statistical methods, Weather patterns.  
Identifiers: \*Persistence (Precipitation).

Values of persistence of precipitation for each of the four seasons have been derived for 108 cities in the conterminous United States. These values show significant differences between stations and seasons and show general behavior of storm systems and atmospheric circulations responsible for precipitation occurrences. Examples are given illustrating the application of persistence to the forecasting problem. The relationship between persistence and the coefficient of correlation involving successive precipitation events is developed. The data presented should serve as important supplementary information in evaluating continuity trends in precipitation. Persistence determinations are presented in tabular form. The basic data on which these derivations are made consist of 15 years of precipitation records for the period December 1949 through November 1964. Persistence is determined for each of the cities by seasons on the condition that precipitation occurred or did not occur in the conditional (preceding) period for eight verifying periods consisting of four 6-hour, two 12-hour, and two 24-hour periods. (Knapp-USGS)  
W71-03673

**ESTIMATION OF BASIN PRECIPITATION BY REGRESSION EQUATION,**  
Meteorological Service of Canada, Toronto (Ontario).  
J. A. W. McCulloch, and M. Booth.  
Water Resources Research, Vol 6, No 6, p 1753-1758, December 1970. 6 p, 2 tab, 4 ref.

Descriptors: \*Precipitation (Atmospheric), \*Data collections, \*Meteorological data, \*Regression analysis, Synoptic analysis, Lake Ontario, Computer programs, Rainfall-runoff relationships.  
Identifiers: \*Canada.

Regressions on 30 years of precipitation data from five stations for the calculation of the monthly amount of precipitation falling on the land portion of the Lake Ontario basin are presented. Verification on three years of test data shows a maximum cumulative annual error of 4%, with individual monthly errors as high as 17%. Provision for missing data is made. (Knapp-USGS)  
W71-03691

**REMOTE RECORDING PRECIPITATION GAGE,**  
For primary bibliographic entry see Field 07B.  
W71-03711

### 2C. Snow, Ice, and Frost

**ON ICE NUCLEATING PROPERTIES OF DIFFERENT FACES OF SILVER IODIDE CRYSTALS,**  
Nagoya Univ. (Japan). Water Research Lab.  
For primary bibliographic entry see Field 03B.  
W71-03430

**VACUUM UV ABSORPTION SPECTRA OF LIQUID WATER AND ICE,**  
For primary bibliographic entry see Field 02K.  
W71-03431

**SOLID PRECIPITATION IN SUPER-COOL Cloud: PART 1 - FREEZING OF A SUPER-COOLED WATER DROP DUE TO THE COLLISION OF ICE CRYSTALS,**  
Nagoya Univ. (Japan). Water Research Lab.  
For primary bibliographic entry see Field 02B.  
W71-03432

**SOLID PRECIPITATION IN SUPERCOOLED CLOUD: PART 2 - GROWTH OF A SOLID PRECIPITATION PARTICLE,**  
Nagoya Univ. (Japan). Water Research Lab.  
For primary bibliographic entry see Field 02B.  
W71-03433

**THE EFFECTS OF THE TIME LAG IN THE ACTIVATION OF ATMOSPHERIC ICE NUCLEI ON THE NUMBER OF ICE CRYSTALS IN CLOUD,**  
Nagoya Univ. (Japan). Water Research Lab.  
For primary bibliographic entry see Field 02B.  
W71-03434

**GROUNDWATER THERMAL REGIME IN A GLACIAL COMPLEX,**  
Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.  
For primary bibliographic entry see Field 02F.  
W71-03464

### 2D. Evaporation and Transpiration

**THE ROLE OF THE MESOPHYLL CELL WALL IN LEAF TRANSPIRATION,**  
Australian National Univ., Canberra. Research School of Biological Sciences.  
For primary bibliographic entry see Field 02I.  
W71-03330

**METEOROLOGICAL DATA AND THE AGRICULTURAL PROBLEM,**  
Connecticut Agricultural Experiment Station, New Haven.  
For primary bibliographic entry see Field 02B.  
W71-03343

**DERIVED METEOROLOGICAL DATA: TRANSPIRATION,**  
Institut for Land and Water Management Research, Wageningen (Netherlands).  
P. E. Rijtema.

Agroclimatological Methods; Proceedings of the Reading Symposium, Natural Resources Research, Vol 7, p 55-72, UNESCO, 1968. 16 fig, 46 ref.

Descriptors: \*Evapotranspiration, \*Interception, \*Diffusion, \*Energy budget, \*Soil-water-plant relationships, Stomata, Lysimeters, Crops, Environmental effects, Mode of action, Meteorological data, Resistance, Precipitation (Atmospheric), Light intensity, Surfaces, Evaporation, Agriculture, Hydrology, Root systems, Leaves, Physiological ecology, Canopy, Soil surfaces, Water loss,

Theoretical analysis, Energy transfer, Equations, Permeability, Water vapor, Turbulence, Instrumentation, Measurement, Data collections.  
Identifiers: \*Agroclimatology, \*Potential evapotranspiration, \*Bowen ratio, \*Leaf tissue suction, \*Partial soil cover, Evaporating surface roughness.

Real evapotranspiration is a function of interacting meteorological, plant physiological and soil physical factors. Since the energies available for water vaporization and vapor transport are the crucial meteorological factors determining evapotranspiration rate, it may be calculated using the turbulent vapor transport method or the Bowen ratio method, and approaches utilizing these methods are discussed. In agricultural and hydrological applications they are limited by the complex instrumentation required. Combined aerodynamic and energy balance methods using standard meteorological data are more practical. Precipitation interception increases total evapotranspiration under all conditions in which reduced transpiration is present. Crop diffusion resistance, which depends on number and size of stomata and the soil cover, can be used to calculate crop transpiration. Real transpiration equals crop transpiration plus intercepted precipitation evaporation. Calculations using this relationship are shown to agree closely with measured evapotranspiration values. Direct determinations of evapotranspiration using the Bowen ratio and turbulent vapor transfer methods, combined with lysimeter studies, suffer from the lack of data on evaporating surface roughness, partial soil cover, light intensity, leaf tissue suction, and interception. (Casey-Arizona)  
W71-03345

**THE USE OF SOIL WATER BALANCE RELATIONSHIPS IN AGROCLIMATOLOGY,**  
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.

R. O. Slater.  
Agroclimatological Methods; Proceedings of the Reading Symposium, Natural Resources Research, Vol 7, p 73-87, UNESCO, 1968. 9 fig, 4 tab, 60 ref.

Descriptors: \*Evapotranspiration, \*Measurement, \*Water balance, \*Soil-water-plant relationships, \*Soil water, Arid lands, Lysimeters, Runoff, Precipitation (Atmospheric), Deep percolation, Instrumentation, Estimating equations, Physiological ecology, Climates, Climatology, Environmental effects, On-site data collections, Evaporation, Interception, Stemflow, Xerophytes, Root systems, Leaves, Crops, Rainfall-runoff relationships, Model studies, Mode of action, Probability, Probable maximum precipitation, Irrigation efficiency, Planning, Soil water movement, Water storage, Storage capacity.

Identifiers: \*Agroclimatology, \*Potential evapotranspiration, \*Soil water balance, \*Australia.

Utilization of soil water balance data for agroclimatological purposes presents many problems where there is a lack of meteorological data. The soil water balance equation includes precipitation runoff, deep drainage, evapotranspiration, and changes in soil water storage. Evapotranspiration is usually deduced from measurements of the other factors. Discussions of each factor in the equation indicate problems involved in measurements, particularly in arid lands. Agroclimatological models using soil water balance data are usually set up on the basis of water budget. Consequently, they require relationships which predict: (1) available soil water storage capacity in the root zone, (2) soil water storage increments resulting from precipitation, (3) drainage below the root zone and (4) surface evapotranspiration. Attempts to predict these phenomena under varying conditions for irrigation planning purposes require simplifying assumptions often likely to lead to error, particularly in arid lands. Factors involving model development for use in the Alice Springs area, Australia, are detailed. Actual potential evapotranspiration patterns for

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different sites and methods for testing and utilizing these models are described. In communities with widely spaced plants, the accuracy of the evapotranspiration model is unsatisfactory. (Casey-Arizona)  
W71-03346

**EFFECTS OF A MONOLAYER ON RESERVOIR TEMPERATURE AND EVAPORATION,**  
Army Electronics Command, Fort Huachuca, Ariz.  
Atmospheric Science Lab.  
For primary bibliographic entry see Field 03B.  
W71-03473

**INHIBITION OF OXYGEN EVOLUTION IN CHLOROPLASTS ISOLATED FROM LEAVES WITH LOW WATER POTENTIALS,**  
Illinois Univ., Urbana. Dept. of Botany.  
J. S. Boyer, and Barbara L. Bowen.  
Plant Physiology, Vol 45, p 612-615, 1970. 5 fig, 19 ref. OWRR Project A-028-ILL (1).

Descriptors: \*Photosynthesis, \*Photosynthetic oxygen, \*Leaves, \*Inhibition, \*Drying, Analytical techniques, Wilting, Carbon dioxide, Plants, Stomata, Centrifugation, Plant tissue, Light intensity, Transpiration control, Measurement, Moisture content, Oxygen, Plant physiology.  
Identifiers: \*Chloroplasts, \*Water potential, \*Oxygen evolution, Carbon dioxide evolution, Alaska pea, Sunflower.

Research was undertaken to determine whether O<sub>2</sub> sub 2 evolution by chloroplasts is inhibited when leaves are exposed to moderate desiccation. Chloroplasts were isolated from leaves of Alaska pea and sunflower by a micro Waring blander and centrifugation. Oxygen evolution was measured with a Clark-type electrode in an assay medium illuminated to saturation into which chloroplasts were injected. Controls from non-desiccated leaves were also measured. CO<sub>2</sub> sub 2 fixation by intact plants was measured for comparisons, using an infrared gas analyzer. Transpiration was measured by collecting water condensed in the assimilation chamber. Isolation of chloroplasts had no effect on O<sub>2</sub> sub 2 evolution. O<sub>2</sub> sub 2 evolution by chloroplasts was reduced in tissue moderately desiccated. The degree of desiccation was more important than the duration. The magnitude of inhibition depended on the species: sunflower was more inhibited than pea. Low leaf water potential affects photosynthesis by inhibition of O<sub>2</sub> sub 2 evolution in chloroplasts and by closure of stomata in intact leaves. Inhibition of O<sub>2</sub> sub 2 evolution has not been previously described in moderately desiccated leaves. Increases in cytoplasmic resistance to CO<sub>2</sub> sub 2 diffusion are probably related to chloroplast changes. The article contains 5 graphs which support the conclusions. (Yensen-Arizona)  
W71-03484

**A STUDY OF EVAPORATION SUPPRESSANTS UNDER GREENHOUSE CONDITIONS: EVALUATIONS I TO IV,**  
Texas Agricultural Experiment Station, College Station.

C. W. Wendt, and J. R. Runkles.

Texas A and M University, Texas Agricultural Experiment Station, Progress Reports: I, PR-2510, (Feb 1968); II, PR-2542, (May 1968); III, PR-2647, (Feb 1969); IV, PR-2646, (Feb 1969). 33 p, 14 fig, 4 tab, 8 ref. OWRR Project B-002-TEX.

Descriptors: \*Evaporation control, \*Greenhouses, \*Evaluation, \*Soil moisture, \*Soil water, Hexadecanol, Ions, Alcohols, Texas, Arid lands, Evaporation, Oxides, Loam, Surfactants, Rates of application, Water loss, Moisture content, Data collections, Treatment.  
Identifiers: \*Crude oil, \*Oils, \*Hyamine, \*Cations, Triton, Latex, Gums, Silicones, Ionic additives, Texas High Plains, Semiarid lands.

These four evaluations trace the progress of greenhouse experiments to suppress evaporation from

soils in the Texas High Plains, where 60 percent of the added rainfall and irrigation water evaporates. Suppressants evaluated were crude oil with and without ionic additives, an oil-latex mixture, polyethylene oxides, silicones, polysaccharide-gum mixture, an amonic and a fatty alcohol. Crude-oil contained suppressants had slower initial evaporation rates from soil pots, while other materials were ineffective. Cationic oil, oil-latex mixture, and polysaccharide-gum mixture further suppressed soil water evaporation. The order of cationic oil effectiveness was Hyamine 3500 more than Hyamine 2389 equal to Hyamine 1622 equal to Triton X-400 more than X-150. Hexadecanol suppressed evaporation less than crude oil. Tables and figures illustrate and quantify these results. (Popkin-Arizona)  
W71-03485

**MEAN EVAPORATION OVER CANADA,**  
Meteorological Service of Canada, Toronto (Ontario).

H. L. Ferguson, A. D. J. O'Neill, and H. F. Cork.  
Water Resources Research, Vol 6, No 6, p 1618-1633, December 1970. 16 p, 10 fig, 2 tab, 19 ref.

Descriptors: \*Evaporation, \*Synoptic analysis, \*Mapping, Water balance, Hydrologic budget, Maps, Hydrologic cycle, Data collections, Meteorological data, Evaporation pans.  
Identifiers: \*Canada, \*Evaporation maps.

Mean monthly and annual maps of evaporation over Canada were prepared. The maps represent time and space averages of evaporation from natural open water bodies having negligible heat storage. The analysis is based on 5-year class A evaporation pan data supplemented by 10-year climatologic data from 100 stations across Canada. The Christiansen formula is shown to be superior to other formulas tested for approximating pan data from other standard climatologic observations. The analysis takes account of the seasonal effects of freeze-up and breakup on the availability of open water. A zonal classification of lake evaporation that emphasizes the large-scale climatic variations in this parameter across Canada is proposed. (Knapp-USGS)  
W71-03678

**EVAPORATION STUDIES IN STANDARD CATCHMENTS,**

Manchester Univ. (England).

H. S. Takhar, and A. J. Rudge.  
Journal of Hydrology, Vol 11, No 4, p 329-362, November 1970. 34 p, 15 fig, 6 tab, 9 ref.

Descriptors: \*Evapotranspiration, \*Evaporation, Meteorological data, Energy budget, Lysimeters, Evaporation pans, Regression analysis, Runoff forecasting.  
Identifiers: \*Potential evapotranspiration.

When estimates of monthly potential transpiration were obtained from meteorological records using theoretical and empirical methods, conflicting trends are revealed by the Penman combination model and the empirical models used. Estimates from short term records from three standard experimental catchments were compared with each other and with observed estimates obtained from lysimeter and evaporation pan readings. Despite significant random errors, the lysimeter estimates appear to be the best. The empirical models indicate very little of the spatial variation in potential transpiration shown by the other methods and their usefulness therefore seems to be restricted. The accuracy of the Penman model appears to vary greatly from site to site. (Knapp-USGS)  
W71-03698

**THE USE OF PANS AND A THEORETICAL MODEL TO DEFINE THE ROLE OF EVAPORATION IN THE WATER BUDGETS OF THE CITY**

**OF LARAMIE AND THE STATE OF WYOMING,**  
Wyoming Univ., Laramie. Dept. of Civil Engineering.

Dennis J. Brown.  
MS Thesis, Wyoming University, June 1970. 133 p, 21 fig, 18 tab, 37 ref, 2 append. OWRR Project A-001-WYO (34).

Descriptors: \*Evaporation, \*Hydrologic data, \*Evaporation pans, \*Water balance, \*Wyoming, Methodology, Climatology, Hydrologic cycle, Meteorology, Solar radiation, Temperature, Lakes, Surface waters, Water balance, Water loss, Wind velocity, Latent heat, On-site data collections.  
Identifiers: \*Laramie (Wyo), \*Evaporation prediction, \*Potential evaporation, \*Lake evaporation, \*Evaporation-analysis methods (Comparison).

Results of estimates of evaporation obtained by means of the inflow-outflow method, evaporation pans, and theoretical equations are compared. Relative amounts of annual evaporation determined by evaporation pans and by theoretical equations are estimated for locations throughout the State of Wyoming, and are compared to current evaporation maps. The water budget study of the Laramie sewage lagoon system provided evidence that the 0.7 Class A pan coefficient is applicable as a means for determining reservoir evaporation. The model equation for lake evaporation derived by Kohler, Nordenson, and Fox provides a more reliable means of estimation since it corrects the amount of pan evaporation for the effects of advected energy through the pan, and for differences in temperature between the air and the water in the pan. Lake evaporation in the Laramie area is equal to approximately 55 inches per year. The amount is appreciably more than the 38 inches read from current evaporation maps of the United States. (Woodard-USGS)  
W71-03729

## 2E. Streamflow and Runoff

**SOME EFFECTS OF HYPOLIMNETIC DISCHARGES ON TEMPERATURES IN THE STREAM BELOW,**  
Wisconsin Univ., Madison. Water Resources Center.

For primary bibliographic entry see Field 05G.  
W71-03308

**ASYMPTOTIC NONLINEAR WAVE MOTION OF A VISCOUS FLUID IN AN INCLINED CHANNEL OF ARBITRARY CROSS SECTION,**  
Wisconsin Univ., Madison. Mathematics Research Center.

For primary bibliographic entry see Field 08B.  
W71-03309

**STREAMFLOW GENERATING TECHNIQUES: A COMPARISON OF THEIR ABILITIES TO SIMULATE CRITICAL PERIODS OF DROUGHT,**

California Univ., Los Angeles. School of Engineering and Applied Science.

Arthur J. Askew, William W-G Yeh, and Warren A. Hall.  
Univ of Calif, Water Resources Center, Contrib No 131, Report No 70-5, January 1970. 24 p, 1 fig, 3 tab, 18 ref, 2 append. OWRR Project B-061-CAL (5).

Descriptors: \*Streamflow, \*Simulation analysis, \*Droughts, \*Rivers, \*Computer programs, Reservoirs, Watersheds, Time, Cost, Synthetic hydrology, Statistical models, Reservoir design, Mathematical models, Streamflow, Forecasting.  
Identifiers: \*Critical periods, Synthetic streamflow records.

A set of monthly streamflow records were generated and analyzed to derive a set of synthetic critical periods. Some characteristics of these

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periods were determined, and the mean and standard deviation of their values were compared with the appropriate values for the historic critical period. The procedure was repeated for twenty-six different rivers, using ten generating techniques. A study of the results allowed a comparison to be made between the generating techniques in regard to both their cost in computer time and their ability to synthesize critical droughts by the relative aridity of watershed, and by the size of the reservoir considered. In addition, some general conclusions were drawn regarding the advisability of using generated streamflow in studies of reservoir design and operation. (Kriss-Cornell)

W71-03314

#### THE QUASI-PERMANENT REGIME OF RIVERS AND THE PREDICTION OF FLOODS, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

For primary bibliographic entry see Field 04A.

W71-03327

#### INSTRUMENTATION AND DEVELOPMENT OF TECHNIQUES TO MEASURE AND EVALUATE METEOROLOGICAL PARAMETERS IMPORTANT TO HYDROLOGY, Utah Water Research Lab., Logan.

For primary bibliographic entry see Field 07A.

W71-03375

#### PROCEEDINGS MISSISSIPPI WATER RESOURCES CONFERENCE, 1970.

Mississippi State Univ., State College. Water Resources Research Inst.

For primary bibliographic entry see Field 04A.

W71-03380

#### HURRICANE CAMILLE ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MISSISSIPPI, Geological Survey, Jackson, Miss.

For primary bibliographic entry see Field 07C.

W71-03381

#### INFLOW OF RIVER WATER TO THE BALTIC SEA IN THE PERIOD 1951-1960, State Inst. for Hydrology and Meteorology, Warsaw (Poland).

Z. Mikulski.  
Nordic Hydrology, Vol 1, No 4, p 216-227, 1970. 12 p, 2 fig, 3 tab, 19 ref.

Descriptors: \*Water balance, \*Sea water, \*Inflow, Hydrologic budget, Streamflow, Snowmelt, Runoff, Precipitation (Atmospheric).  
Identifiers: \*Baltic Sea.

The inflow of river water to the Baltic Sea is evaluated for the period 1951-60. A proposal is made for a re-evaluation of the estimates for earlier periods and for future computations on a continuous basis. The Baltic Sea received in the period 1951-1960 about 440 cu km of water. The annual discharge into the Baltic corresponds to 2 percent of the total water volume. Studies recently made in Poland indicate that the discharge in the period 1951-1960 was several percent below the long-term average. The greatest inflow of stream water is in spring (April-June) with a maximum in May (14 percent). Minimum inflow, amounting to 50 percent of the maximum values, occurs in winter (November-January), at the period of dominant sea storms. (Knapp-USGS)

W71-03392

#### AN IMPLEMENTATION OF STAGE-FALL-DISCHARGE RELATIONSHIP ON DIGITAL COMPUTERS, Norges Vassdrags- og Elektrisitetsvesen, Oslo. Bo Wingard.

Nordic Hydrology, Vol 1, No 4, p 228-234, 1970. 7 p, 1 fig, 3 tab, 3 ref.

Descriptors: \*Stage-discharge relations, \*Data processing, \*Digital computers, Slopes, Open channel flow, Discharge coefficients, Streamflow, Water levels, Mannings equation, Discharge measurement.

Identifiers: Norway.

Discharge conversions on digital computers for gages where a slope-stage discharge relationship is recommended seem to give good results by employment of a relationship between the mean-stage and the friction parameter. The method gave satisfactory accordance between computed and measured discharge. A correction of the friction curve on the basis of later measurement is simple. As with all slope-stage-discharge methods, the discharge measurements have to be made over a sufficiently long mean-stage and discharge interval. (Knapp-USGS)

W71-03393

#### COMPILATION OF HYDROLOGIC DATA, DEEP CREEK, COLORADO RIVER BASIN, TEXAS, 1968.

Geological Survey, Austin, Tex. Water Resources Div.

For primary bibliographic entry see Field 07C.

W71-03398

#### COMPILATION OF HYDROLOGIC DATA, HONEY CREEK, TRINITY RIVER BASIN, TEXAS, 1968.

Geological Survey, Austin, Tex. Water Resources Div.

For primary bibliographic entry see Field 07C.

W71-03399

#### COMPILATION OF HYDROLOGIC DATA, GREEN CREEK, BRAZOS RIVER BASIN, TEXAS, 1968.

Geological Survey, Austin, Tex. Water Resources Div.

For primary bibliographic entry see Field 07C.

W71-03400

#### PARAMETERIZATION OF OBSERVED HYDROGRAPHS,

Vermont Univ., Burlington. Dept. of Civil Engineering.

Richard N. Downer.

Available from NTIS as PB-196 899, \$3.00 in paper copy, \$0.95 in microfiche. Vermont University Water Resources Research Center Report 1, December 1970. 57 p, 6 fig, 5 tab, 14 ref, 2 append. OWRR Project No A-008-VT (1).

Descriptors: \*Hydrograph analysis, \*Statistical methods, \*Computer programs, Regression analysis, Routing, Flood forecasting, Computer models, Hydrographs, Mathematical models, Simulation analysis, Data processing, Optimization, Least squares method, Vermont.

Identifiers: \*Curve fitting, Sleepan River watershed (Vt.).

A simple transformation of the incomplete gamma function was used to describe single-peaked hydrographs. A weighted least-squares method produces a forced fit of the crest portion of the observed hydrograph. In addition to determining the parameters of the fit with minimum squared deviations, the computer plots the original and fitted hydrographs and calculates statistics to assist in making an objective decision as to the hydrological goodness-of-fit. A good least-squares fit does not necessarily result in a good hydrologic fit. Judgment of goodness-of-fit on the central portion of the hydrograph is aided by a significance test which combines the number of data points with features of the ocular fit (balancing of volumes and minimizing of deviations). The complete goodness-of-fit test assumes that: (1) the assumed model is correct; and (2) if the model is a correct one, there is a close mathematical relation between the observed and fitted data. (Knapp-USGS)

W71-03665

#### FLOOD REGULATION BY COLUMBIA TREATY PROJECTS, Corps. of Engineers, Portland, Oreg. Water Control Branch.

For primary bibliographic entry see Field 04A.  
W71-03666

#### EFFECT OF CHANNEL SHAPE ON GRADUALLY VARIED FLOW PROFILES, Indian Inst. of Science, Bangalore. Dept. of Civil and Hydraulic Engineering.

For primary bibliographic entry see Field 08B.  
W71-03669

#### HYDRAULIC JUMP WITHIN GRADUALLY EXPANDING CHANNEL,

Asian Inst. of Technology, Bangkok (Thailand). Dept. of Hydraulic Engineering, and Mindanao Development Authority (Philippines).

For primary bibliographic entry see Field 08B.

W71-03670

#### SMALL SAMPLE PROPERTIES OF H AND K-ESTIMATORS OF THE HURST COEFFICIENT h,

Thomas J. Watson Research Center, Yorktown Heights, N. Y.; and Geological Survey, Washington, D.C.

James R. Wallis, and Nicholas C. Matalas. Water Resources Research, Vol 6, No 6, p 1583-1594, December 1970. 12 p, 21 fig, 8 tab, 10 ref.

Descriptors: \*Statistics, \*Streamflow, \*Time series analysis, \*Correlation analysis, Statistical methods, Frequency analysis, Stochastic processes, Probability, Markov processes.

Identifiers: \*Hurst phenomenon, \*Potomac River.

Seasonal differences in long-term persistence ( $h$  greater than 0.5), were found for 25 streams in the Potomac River basin. Two statistics,  $H$  and  $K$ , used as estimators of  $h$  were found to have differing small sample properties.  $K$  was found to have less variance but a greater positive bias than  $H$ . However, the Hurst phenomenon, in which  $H$  and  $K$  values differ from the expected values for independent series, was confirmed for the Potomac River basin streamflows. Neither marginal distribution nor biased transience appear to be viable explanations for the differences between observed and independent or short memory simulated sequences. For the Potomac basin, the explanation of  $h$  being greater than 0.5 can only be attributed to the nature of the correlation structure of the observed series. (Knapp-USGS)

W71-03674

#### RELIABILITY OF A VARIANCE ESTIMATE OBTAINED FROM A SAMPLE AUGMENTED BY MULTIVARIATE REGRESSION,

Geological Survey, Arlington, Va.

For primary bibliographic entry see Field 07A.

W71-03675

#### COMPARING POWER SPECTRA COMPUTED BY BLACKMAN-TUKEY AND FAST FOURIER TRANSFORM,

United States Lake Survey, Detroit, Mich.

Billy L. Edge, and Paul C. Liu. Water Resources Research, Vol 6, No 6, p 1601-1610, December 1970. 10 p, 15 fig, 7 ref.

Descriptors: \*Fourier analysis, \*Time series analysis, \*Statistical methods, Numerical analysis, Statistics, Time lag.

Identifiers: \*Blackman-Tukey method, \*Power spectrum analysis.

To determine whether the Blackman-Tukey or the fast Fourier transform (FFT) technique should be used to compute power spectra, single and cross spectra were computed by each approach to provide an empirical means for determining which should be used. The spectra were computed for five time series, two sets of which were actual field data.

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In general the two approaches give similar estimates. For a spectrum with a large slope, the FFT approach allowed more window leakage than the Blackman-Tukey approach. On the other hand, the Blackman-Tukey approach demonstrated a better window closing capability. It is concluded that the Blackman-Tukey technique is more effective than the FFT approach in computing power spectra of short historic time series, but for long records the fast Fourier transform is the only feasible approach. (Knapp-USGS)  
W71-03676

**A STOCHASTIC MODEL FOR FLOOD ANALYSIS,**

Colorado State Univ., Fort Collins.  
P. Todorovic, and E. Zelenhasic.  
Water Resources Research, Vol 6, No 6, p 1641-1648, December 1970. 8 p, 9 fig, 7 ref. NSF Grants 11444 and 11499.

Descriptors: \*Stochastic processes, \*Statistical models, \*Flood forecasting, Frequency analysis, Time series analysis, Pennsylvania, Probability, Data collections, Hydrograph analysis, Model studies, Mathematical models.  
Identifiers: \*Stochastic models, \*Flood analysis, Susquehanna River (Pa.).

A stochastic model, based on the recent developments in the theory of extreme values, is presented to describe and analyze excessive streamflows. The model is a particular stochastic process defined as the maximum term among a random number of random observations in an interval of time. Since the number of hydrographs peaks that exceed a certain level and the magnitudes of these peaks are random variables, the model seems to conform well to the flood phenomenon. The passage time of the process relevant to the risk evaluation in the design of hydraulic structures is also considered. The results obtained are applied on the 72-year record of the Susquehanna River at Wilkes-Barre, Pennsylvania. Theoretical and observed results agree reasonably well. (Knapp-USGS)  
W71-03680

**STATISTICAL DECISION THEORY TECHNIQUES FOR THE REVISION OF MEAN FLOOD FLOW REGRESSION ESTIMATES,**

Carnegie-Mellon Univ., Pittsburgh, Pa.  
Richard M. Shane, and Donald P. Gaver.  
Water Resources Research, Vol 6, No 6, p 1649-1654, December 1970. 6 p, 2 tab, 9 ref.

Descriptors: \*Flood forecasting, \*Decision making, \*Regression analysis, \*Statistical models, Flood protection, Economics, Time series analysis, Probability, Frequency analysis, Data collections, Peak discharge, Variability.  
Identifiers: \*Flood analysis, Flood peak forecasting.

Two statistical estimating procedures are presented for using regression information along with direct observations to obtain estimates of the expected value of peak flood discharge rates exceeding a constant base. The first type of estimate represents the minimum mean squared error linear combination of regression and direct estimates, whereas the second is a Bayesian estimate based on an objective prior distribution associated with the regression model. A comparison of combined estimates to regression and direct estimates used alone indicates that a significant reduction in the mean squared error is obtained by using combined estimates. A comparison of the two methods for obtaining a combined estimate indicates that in many cases they both give essentially the same result. (Knapp-USGS)  
W71-03681

**TOPOLOGICAL AND GEOMETRICAL PROPERTIES OF BRAIDED STREAMS,**

Virginia Univ., Charlottesville.  
For primary bibliographic entry see Field 02J.  
W71-03683

**FLOOD SERIES COMPARED TO RAINFALL EXTREMES,**

Pennsylvania State Univ., University Park.  
Brian M. Reich.  
Water Resources Research, Vol 6, No 6, p 1655-1667, December 1970. 13 p, 9 fig, 5 tab, 14 ref.

Descriptors: \*Rainfall-runoff relationships, \*Flood forecasting, \*Peak discharge, \*Rainfall intensity, \*Statistical methods, Probability, Pennsylvania, Correlation analysis, Variability.  
Identifiers: \*Flood analysis.

Annual series of maximum instantaneous flood peaks from 26 Pennsylvania watersheds smaller than 200 square miles were analyzed by the Gumbel, log Gumbel, and log Pearson 3 methods. An empirical appraisal of how well each of these mathematical curves fits the data shows the general applicability of the straight Gumbel line. Consistent overestimation of long return period extremes results from using the log Gumbel analysis. Advantages of slight flattening for very rare expectations, which can result from the log Pearson 3 and the types of data sets preventing overestimation, are discussed. Corresponding histories of daily and clock hourly extreme rainfall annual series were compared to flood series for 24 watersheds that had more than one half of their drainage areas within a 14-mile radius of the rain gage. Extreme rains that occur during the spring are more strongly linked to annual floods than yearly maximum rainfall are. No usable relationship could be found between the extreme value statistics of rainfall and floods. (Knapp-USGS)  
W71-03685

**MULTIPLE GRAVITY WELLS UNDER TRANSIENT STATES OF FLOW,**

North Carolina State Univ., Raleigh.  
Abdel-Aziz I. Kashef.  
Water Resources Research, Vol 6, No 6, p 1729-1736, December 1970. 8 p, 2 fig, 12 ref.

Descriptors: \*Groundwater movement, \*Drawdown, \*Unsteady flow, \*Water wells, Aquifers, Water level fluctuations, Theis equation, Steady flow, Diffusivity, Porous media, Artesian wells, Mathematical studies.  
Identifiers: \*Multiple-well drawdown.

A method for finding the flow pattern of several wells pumped into an unconfined aquifer under transient conditions is based on the results of the study of individual wells using the relationships between the hydraulic forces. A flow equation called the 'unified well formula' is developed and written in terms of the areas of the pressure head diagrams across vertical sections. The free surface of an individual gravity well is derived in a general procedure similar to that for steady state cases but introducing time effects. The equation can be solved numerically in one iterative cycle at a given time. The results of the analysis of single wells are used to determine the flow pattern of a multiple well system under transient conditions of flow. The restricted superposition principles used in steady state cases are also used for transient flow. Dupuit's assumptions are eliminated and the circumferential velocities are neglected. The derived equations are further investigated at small radii or at large values of time. The equation of the free surface reduces to the same form as that of the corresponding steady state cases. However, the radius of influence, in the transient case, depends on the time and the diffusivity of the flow medium. (Knapp-USGS)  
W71-03687

**SIMULATION AND EVALUATION OF COMPLEX WATER SYSTEMS OPERATIONS,**

Australian National Univ., Canberra.  
P. A. P. Moran.  
Water Resources Research, Vol 6, No 6, p 1737-1742, December 1970. 6 p, 5 ref.

Descriptors: \*Statistical models, \*Time series analysis, \*Markov processes, Stochastic processes, Simulation analysis, Optimization, Systems analy-

sis, Correlation analysis, Streamflow forecasting, Probability, Variability.  
Identifiers: \*Streamflow models.

The production of long artificial series of multiple streamflows is considered, taking into account non-normal distributions, serial dependence, seasonal variation, and the correlation between different streams. It is proposed that the distribution of flows for a given stream and month be fitted by gamma type distributions, and that these distributions then be transformed to obtain normally distributed variates. A separate canonical correlation analysis for each successive pair of months yield a nonstationary seasonally varying Markovian process that is then transformed back into the original nonnormal variates. The uses of such simulated series for calculating the probability behavior of a system of dams and for the approximate optimization of their operation is described, together with the estimation of standard errors. (Knapp-USGS)  
W71-03688

**ON TESTING THAT THE DISTRIBUTION OF EXTREMES IS OF TYPE I WHEN TYPE II IS THE ALTERNATIVE,**

Agricultural Univ., Wageningen (Netherlands).  
M. A. J. Van Montfort.  
Journal of Hydrology, Vol 11, No 4, p 421-427, November 1970. 7 p, 1 fig, 2 tab, 2 ref.

Descriptors: \*Statistical methods, \*Statistics, \*Mathematical studies, Probability, Sampling, Time series analysis, Data collections.  
Identifiers: \*Extreme value probability.

Distributions of largest extremes are normally used to estimate tail probabilities. When dealing with unlimited extremes, the question arises which type of distributions of extremes is adequate. Sometimes the Gumbel distribution (type I), which can be regarded as a restriction of the log-Gumbel distribution (type II), is used without sufficient support for this choice; estimated extreme tail probabilities can then be more influenced by the choice of the type than by the data. This paper gives a quick test with high power where type I is the null hypothesis and type II is the alternative; it is based on a study dealing with the reduction of power as a consequence of using numerically simplified tests. (Knapp-USGS)  
W71-03697

**SOME EXTENSIONS OF TWO-STREAMS STORAGE MODEL,**

Lancaster Univ., Bailrigg (England).  
For primary bibliographic entry see Field 04A.  
W71-03699

**A SALT TRACING METHOD FOR MEASURING CHANNEL VELOCITIES IN SMALL MOUNTAIN STREAMS,**  
Maine Univ., Orono; and Sleepers River Research Watershed, Danville, Vt.  
For primary bibliographic entry see Field 07B.  
W71-03700

**SOLUTION OF STEADY FLOW IN OPEN CHANNELS BY GRAPHS,**

Tarbela Dam Project, Hazara (West Pakistan).  
For primary bibliographic entry see Field 08B.  
W71-03702

**COMPILATION OF HYDROLOGIC DATA, CALAVERAS CREEK, SAN ANTONIO RIVER BASIN, TEXAS, 1968.**

Geological Survey, Austin, Tex. Water Resources Div.  
For primary bibliographic entry see Field 07C.  
W71-03704

**THE ALASKAN EARTHQUAKE, MARCH 27, 1964: LESSONS AND CONCLUSIONS,**  
Geological Survey, Washington, D.C.

## Field 02—WATER CYCLE

### Group 2E—Streamflow and Runoff

Edwin B. Eckel.

For sale by the Superintendent of Documents, US Government Printing Office, Wash, DC 20402 - Price \$0.75. Geological Survey Professional Paper 546, 1970. 57 p, 2 fig, 145 ref.

Descriptors: \*Earthquakes, \*Alaska, \*Hydrogeology, Faults (Geology), Fractures (Geology), Floods, Landslides, Land subsidence, Seismic waves, Tsunamis, Waves (Water), Flood damage, Mudflows, Clays, Quick clays.

Identifiers: \*Alaska Earthquake (1964).

One of the greatest earthquakes of all time struck south-central Alaska on March 27, 1964. In some coastal areas, local subsidence was superimposed on regional tectonic subsidence to heighten the flooding damage. Ground and surface waters were measurably affected by the earthquake, not only in Alaska but throughout the world. Much new and corroborative basic geologic and hydrologic information was accumulated in the course of the earthquake studies, and may new or improved investigative techniques were developed. Chief among these, perhaps, were the recognition that lakes can be used as giant tiltmeters, the refinement of methods for measuring land-level changes by observing displacements of barnacles and other sessile organisms, and the relating of hydrology to seismology by worldwide study of hydroseisms in surface-water bodies and in wells. The volume closes with a selected bibliography and a comprehensive index to the entire Alaska Earthquake series of U. S. Geological Survey Professional Papers 541-546. (Knapp-USGS)

W71-03706

#### STREAMFLOW RECORDS OF THE SNOWY MOUNTAINS REGION, AUSTRALIA TO 1965 - VOLUME 1: GENERAL INFORMATION AND MURRUMBIDGEE RIVER BASIN.

Snowy Mountains Hydro-Electric Authority, Cooma (Australia). For primary bibliographic entry see Field 07C.

W71-03708

#### STREAMFLOW RECORDS OF THE SNOWY MOUNTAINS REGION, AUSTRALIA TO 1965 - VOLUME 2: UPPER MURRAY RIVER BASIN.

Snowy Mountains Hydro-Electric Authority, Cooma (Australia).

For primary bibliographic entry see Field 07C.

W71-03709

#### STREAMFLOW RECORDS OF THE SNOWY MOUNTAINS REGION, AUSTRALIA TO 1965 - VOLUME 3: SNOWY RIVER BASIN.

Snowy Mountains Hydro-Electric Authority, Cooma (Australia).

For primary bibliographic entry see Field 07C.

W71-03710

#### ESTIMATE OF TURBULENCE AND HYDRAULIC RESISTANCES DURING WAVE MOTION IN BODIES OF WATER,

V. A. Znamenskiy.

Trans from Gosudar Gidrolog Inst-Ta, No 169, 1969. Soviet Hydrology: Selected Papers, No 4, p 364-370, 1969. 7 p, 2 fig, 3 tab, 12 ref.

Descriptors: \*Turbulent flow, \*Waves (Water), \*Fluid friction, \*Energy dissipation, \*Flow resistance, Turbulence, Unsteady flow, Non-uniform flow, Steady flow, Roughness (Hydraulic), Reynolds number.

Identifiers: \*Hydraulic resistance.

Studies of the kinematics and of the character of fluid motion in bodies of water show that the main losses of energy in turbulent flow and wave action occur in the bottom layer. The hydraulic resistance coefficient, characterizing energy losses, is determined through the Reynolds number and the relative thickness of the bottom layer. The energy losses and the turbulence of wave flow may be estimated from known wave elements. The relation-

ships obtained can also be used to simulate analogous processes in the laboratory. (Knapp-USGS)

W71-03713

#### EXPERIMENTAL STUDY OF RAINFALL RUNOFF,

Gidrometeorologicheskii Institut, Odessa (USSR). For primary bibliographic entry see Field 02A.

W71-03719

#### ESTIMATION OF DESIGN FLOOD DISCHARGES ESPECIALLY FOR RIVER VALLEY PROJECT IN INDIA,

Ministry of Irrigation and Power (India); and Central Water and Power Commission, New Delhi (India).

P. Ahuja, and R. Shenoy.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), p 252-258, 1969. 7 p, 1 fig.

Descriptors: \*Streamflow forecasting, \*Floods, \*Design flood, Discharge (Water), Flood plains, Hydraulics, Dams, Bridges, Flood forecasting, Design criteria, Design flow, Peak discharge, Hydraulic design.

Identifiers: \*India.

The cause and effects of floods in India are briefly outlined. The need for ensuring safety of hydraulic structures against floods in river valley projects is stressed. The criteria for the estimation of design floods for different types and categories of structures are discussed both when there is enough hydrometeorological data, and in cases when there is lack of data. Particular situations when there is a series of structures on the same river or river system are also considered. Lesser criteria adopted for hydraulic structures other than dams, such as weirs, drainage works, bridges, etc. are also discussed. Special reference has been made to railway bridges regarding which extensive basic studies are being conducted to evolve regional formulas for estimation of design floods in order to determine their waterways. (Knapp-USGS)

W71-03721

#### ON PRINCIPLES OF ESTIMATION METHODS OF MAXIMUM DISCHARGE,

State Hydrological Inst., Leningrad (USSR).

S. N. Kritsky, and M. F. Menkel.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), p 29-41, 1969. 13 p, 3 fig, 21 ref.

Descriptors: \*Floods, \*Analytical techniques, \*Estimating, \*Flood forecasting, Hydrograph analysis, Discharge (Water), Peak discharge, Rainfall-runoff relationships, Storm runoff, Snowmelt, Statistical methods, Probability.

Identifiers: Flood peak estimation.

To calculate rare extreme discharge without sufficient data, additional information on maximum discharge of similar rivers may be used. Such methods are effective for rivers with moderate variations of annual maxima typical of snowmelt regimes. Theoretical curves of probability distribution can compare the performance of different rivers. Another principal estimation system is based on meteorological data as well as the variability of discharge maxima, displacement, and error of estimation of parameters of the distribution of maximum discharge probabilities. Some basic features of USSR state standardization of evaluation methods for maximum discharges are discussed. (Knapp-USGS)

W71-03722

#### DETERMINATION OF MAXIMUM POSSIBLE FLOOD FLOW USING THE UNIT HYDRO-

#### GRAPH AND THE 'MAXIMUM DURATION INTENSITY' CURVE (FRENCH),

Universite Federale du Cameroun, Yaounde.

D. le Gourieres.

In: Floods and Their Computation, Vol 1, International Association of Scientific Hydrology Publication No 84 (Unesco-WMO), p 193-201, 1969. 9 p, 6 fig.

Descriptors: \*Flood forecasting, \*Hydrograph analysis, \*Duration curves, Hyetographs, Unit hydrographs, Rainfall-runoff relationships, Probable maximum precipitation, Infiltration, Groundwater movement, Discharge (Water), Peak discharge.

Identifiers: Maximum discharge prediction.

Determining maximum flood discharges on the basis of the unit hydrograph and the rainfall intensity duration curve for the region of the river basin is discussed. For this purpose it is sufficient to plot the 'ranked' unit hydrograph and the 'ranked' hyetogram of the most 'dangerous' storm. Then the corresponding ordinates of the ranked unit hydrograph are multiplied by the ranked hyetogram ordinates. The area contained between the runoff curve and the X-axis represents the possible maximum discharge. In order to derive the probable maximum flood discharge it is sufficient to add the maximum groundwater discharge. (Knapp-USGS)

W71-03723

#### FLOOD HYDROLOGY OF SMALL WATERSHEDS—EVALUATION OF TIME PARAMETERS AND DETERMINATION OF PEAK DISCHARGE,

Hawaii Univ., Honolulu. Dept. of Agricultural Engineering.

I-pai Wu.

Hawaii University Water Resources Research Center Contribution No 13, Project Completion Report, December 1968. 33 p, 11 fig, 2 tab, 19 ref. OWRR Project B-006-HI (1).

Descriptors: \*Rainfall-runoff relationships, \*Urbanization, \*Floods, \*Peak discharge, Hydrograph analysis, Regression analysis, Recession curves, Flood routing, Rational formula, Small watersheds, Time of concentration, Precipitation intensity.

Identifiers: \*Flood hydrology, \*Oahu (Hawaii).

Hawaiian small watersheds are short and steep. Both of the two hydrograph time parameters, time to peak and recession constant, are short. The shape of the flood hydrograph is a steep triangle and most likely produced by a short duration, high intensity rainfall. Peak discharge equations which are derived by three different approaches, triangular hydrograph, instantaneous unit hydrograph, and overland flow analysis, can all be shown as a simple linear equation. A linearity test between peak discharge and runoff has been made for the small watersheds and a good linear relationship was found between peak discharge and for runoff less than 6 inches. (Knapp-USGS)

W71-03724

#### SPECTRAL MEASUREMENTS AND GROWTH RATES OF WIND-GENERATED WATER WAVES,

Stanford Univ., Calif. Dept. of Civil Engineering.

Alex J. Sutherland.

Stanford University Department of Civil Engineering Technical Report No 84, August 1967. 64 p, 19 fig, 9 tab, 23 ref. ONR Contract Nonr-225 (71), and NSF Grant GK-736.

Descriptors: \*Waves (Water), \*Winds, \*Hydraulic models, \*Frequency analysis, Frequency, Wind velocity, Wavelengths.

Identifiers: \*Wind-generated water waves, \*Wave tanks, Water wave spectra.

Power spectral density measurements were made of the water surface displacement in a wind-generated wave train. Growth rates of different

wave components were determined from the measured spectra. The resulting values were compared with those predicted by the viscous Reynolds stress mechanism of energy transfer from wind to wave. Where the growth was exponential the theory could be made to predict growth rates successfully at wave numbers less than 15.0 per ft. At higher wave numbers the theory predicted values an order of magnitude larger than those measured. Limited regions of linear growth were found at the lowest wind speed for low frequency components. The scatter in the data did not permit a quantitative comparison with theory to be made for this range. No equilibrium range was found. (Knapp-USGS) W71-03726

#### THE EFFECT OF RAINFALL ON THE MECHANICS OF STEADY SPATIALLY VARIED SHEET FLOW ON A HYDRAULICALLY SMOOTH BOUNDARY,

Illinois Univ., Urbana. Dept. of Civil Engineering.

Yong Nam Yoon.

PhD Thesis, Illinois University, 1970. 187 p, 71 fig, 4 tab, 66 ref, 5 append. OWRR Project B-018-ILL (2).

Descriptors: \*Rainfall-runoff relationships, \*Overland flow, \*Hydraulic models, \*Sheet flow, Mathematical models, Equations, Rainfall intensity, Boundaries (Surfaces), Runoff, Flow resistance, Channel morphology, Topography, Reynolds number, Flow rates, Steady flow, Turbulent flow, Shear stress, Spatial distribution, Demonstration watersheds, Simulated rainfall.  
Identifiers: \*Experimental watersheds.

The effect of rainfall intensity, Reynolds number and channel slope on the point mean velocity distribution over the vertical, momentum coefficient, longitudinal relative turbulence intensity profile and local mean boundary shear stress is studied. The local mean boundary shear stress was obtained by two methods: the numerical solution of one-dimensional steady spatially varied flow equation with the water surface profile measured; and by direct measurement using a hot-film sensor. These methods are compared and the validity of a one-dimensional equation is discussed. The law of resistance is also established using correlation analysis and experimental results. The Reynolds number and rainfall intensity are found to be the most significant parameters governing the flow resistance. Mathematical models for the description of the upper and lower portion of a velocity profile are developed and compared with experimental measurements. It was concluded that Reynolds number and rainfall intensity are the most important parameters affecting the boundary shear stress. (Woodard-USGS)  
W71-03727

#### SOLUTION OF THE UNSTEADY FLOW EQUATIONS AND ITS USE IN MODELING THE SURFACE RUNOFF PROCESS,

Utah Water Research Lab., Logan.

Roger A. Amisial, J. Paul Riley, Kenneth G. Rennard, and Eugene K. Israelsen.

Research Project Progress Report to Soil and Water Conservation Research Division, Agricultural Research Service, United States Department of Agriculture, May 1969. 66 p, 12 tab, 46 fig, 52 ref.

Descriptors: \*Surface runoff, \*Hydrologic models, \*Simulation, \*Analog computers, Infiltration, \*Runoff, Rainfall, Watershed (Basins), Precipitation, Convective storms, Water yields, Water yield improvement, Hydrologic relationships, Hydrologic data, Water resources development, Planning.

The flow of water on a watershed is usually unsteady and spatially varied, but can be adequately portrayed by the equations of momentum and continuity, commonly referred to as the unsteady flow equations. Because these equations are quasilinear, hyperbolic, partial differential equations, they are not easily amenable to solution. Analog

computer models of surface runoff generally have been based on simplified forms of these equations. As an improvement of those models, an analog computer solution is presented here for the unsteady flow equations. The solution involves the conversion of the partial differential equations into a differential-difference system, and a consideration of the stability of the difference approach was performed. The analog computer solution is then used to develop a model of surface runoff generated from rainfall on a watershed. Spatial distribution of the watershed parameters is accounted for by dividing the drainage basin into a number of subzones according to its physiography and the rainfall input was made to each subzone. Both the overland and channel flow components are considered in the surface runoff process. Preliminary testing and verification of the model have been made by simulating two runoff events on a subwatershed of the Walnut Gulch experimental watershed near Tombstone, Arizona. (See also W70-05118 and W70-04575)  
W71-03776

## 2F. Groundwater

#### DELINeATION OF GROUNDWATER FLOW SYSTEMS IN NEVADA,

Nevada Univ., Reno. Center for Water Resources Research.

For primary bibliographic entry see Field 04B.  
W71-03302

#### MODEL STUDIES OF SALT WATER INTRUSION,

North Carolina State Univ., Raleigh. Dept. of Civil Engineering.

For primary bibliographic entry see Field 02L.  
W71-03316

#### DOWSING EXPERIMENTS,

Institute for Industrial Research and Standards, Dublin (Ireland).

For primary bibliographic entry see Field 07C.  
W71-03389

#### CROSS-SPECTRUM ANALYSIS OF GROUNDWATER LEVELS IN AN ESKER,

Stockholm Univ. (Sweden). International Meteorological Inst.

Erik Eriksson.  
Nordic Hydrology, Vol 1, No 4, p 245-259, 1970. 15 p, 13 fig, 2 tab, 2 ref.

Descriptors: \*Water level fluctuations, \*Surface-groundwater relationships, \*Time series analysis, Glacial drift, Statistical methods, Frequency analysis, Streamflow forecasting, Water levels, Aquifers, Regression analysis.  
Identifiers: \*Cross-spectral analysis, Sweden.

A study of 30-year records of precipitation, river water stage, and groundwater levels in the esker area south of Uppsala, Sweden used cross-spectrum analysis to summarize data in coherence graphs for frequencies up to 18 cycles/year and tables of phase shifts for selected frequencies. The coherence between precipitation and the other variables is extremely weak or absent. The river water level and groundwater levels show appreciable coherence relatively independent of frequency, suggesting that variation in groundwater levels runs parallel to variations in river water stage. The coherence between groundwater levels, however, is such that interaction is suggested. The phase shift between river water level and groundwater level is approximately 10-30 days with the groundwater levels lagging. The magnitude of phase shift seems to depend on the distance between ground surface and groundwater level. (Knapp-USGS)  
W71-03394

#### THEORY OF GROUNDWATER FLOW,

Technische Hogeschool, Delft (Netherlands).

A. Verruijt.

New York, Macmillan and Company, 1970. 190 p.

Descriptors: \*Groundwater movement, \*Soil water movement, Analytical techniques, Seepage, Darcys law, Dupuit-Forchheimer theory, Computer programs, Analog models, Permeability, Viscosity, Flow, Porous media, Aquifers, Model studies.  
Identifiers: Finite element method, Textbooks.

The aim of this book is to present the fundamentals of the theory of groundwater flow and the most effective methods for solving groundwater flow problems occurring in practice. Technical and practical aspects are not discussed. Although the book is in principle intended to be an introductory text, some theoretically rather complicated methods, notably the complex variable method, analog methods, and the finite element are included. Among the problems discussed are those connected with seepage through earth dams, underneath hydraulic structures and problems related to the supply of drinking water. In general the problem is to determine the velocity and the pressure of the water in the interior of a soil mass with given boundaries, under certain imposed conditions along these boundaries. Mathematically speaking, the problem is in the class of boundary-value problems. (Knapp-USGS)  
W71-03397

#### GROUNDWATER SYMPOSIUM.

Watson, K. K., editor. Proceedings of Groundwater Symposium held at New South Wales University, Manly Vale, Australia, August 28-29, 1969: New South Wales University Water Research Laboratory Report No 113, April 1970. 189 p.

Descriptors: \*Water resources development, \*Systems analysis, \*Groundwater movement, \*Hydrogeology, \*Conjunctive use, Computer models, Analog models, Model studies, Water management (Applied), Water yield, Aquifers, Reviews, Research and development.  
Identifiers: \*Australia.

The School of Civil Engineering of the University of New South Wales presents a symposium of 12 papers with particular emphasis on contemporary groundwater studies in Australia. The symposium program was centered on groundwater from unconsolidated sediments, groundwater recharge, systems analysis studies, digital and analog models in groundwater investigations, and conjunctive use of surface water and groundwater. (See also W71-03402 thru W71-03405) (Knapp-USGS)  
W71-03401

#### GROUNDWATER IN UNCONSOLIDATED SEDIMENTS - RECENT DEVELOPMENTS IN NEW SOUTH WALES,

Water Conservation and Irrigation Commission (Australia).

For primary bibliographic entry see Field 04B.

W71-03402

#### NON-DARCY FLOW IN THE VICINITY OF WELLS,

New South Wales Univ., Kensington (Australia).

School of Civil Engineering.

C. R. Dudgeon, and C. N. Au Au Yeung.

In: Proceedings of Groundwater Symposium, New South Wales University, Manly Vale, Australia, August 28-29, 1969: New South Wales University Water Research Laboratory Report No 113, Paper No 2, p 13-27, April 1970. 15 p, 6 fig, 14 ref.

Descriptors: \*Groundwater movement, \*Darcys law, \*Dupuit-Forchheimer theory, \*Head loss, Hydrodynamics, Flow nets, Turbulent flow, Hydraulic conductivity, Mathematical studies, Permeability, Drawdown, Velocity, Water yield.  
Identifiers: \*Australia, Finite difference method.

The velocity-hydraulic gradient relationships which are applicable to non-Darcy flow in the vicinity of

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wells and their application in determining flow rates and drawdowns are described. Methods available for computing non-Darcy flow nets are discussed and practical difficulties involved in determining the constants in the head loss equation are considered. Determination of drawdowns in wells where non-Darcy flow occurs required the computation of nonlinear flow nets. This may be done on the digital computer using finite difference or finite element methods. Accurate knowledge of the type of material and state of compaction of aquifer and gravel pack materials close to the well is required for the constants in the head loss equation to be accurately determined. The only reliable way at present of determining the constants in the head loss equation is by carrying out permeameter tests. The effect of convergence of the flow on the constants required close attention. (See also W71-03401) (Knapp-USGS)  
W71-03403

**THEORY AND APPRAISAL OF HYDRAULIC CONDITIONS IN WELLS,**  
Water Conservation and Irrigation Commission (Australia).  
For primary bibliographic entry see Field 08B.  
W71-03404

**ONE-DIMENSIONAL GROUNDWATER RECHARGE,**  
New South Wales Univ. Kensington (Australia).  
School of Civil Engineering.

K. K. Watson.  
In: Proceedings of Groundwater Symposium, New South Wales University, Manly Vale, Australia, August 28-29, 1969; New South Wales University Water Research Laboratory Report No 113, Paper No 4, p 50-59, April 1970. 10 p, 3 fig, 10 ref.

Descriptors: \*Infiltration, \*Recharge, \*Soil water movement, \*Instrumentation, \*Reviews, Unsaturated flow, Unsteady flow, Porous media, Hydrogeology, Numerical analysis.

The hydrologic significance of water movement in the unsaturated zone is discussed with particular reference to one-dimensional groundwater recharge. The relationships which characterize the hydrologic behavior of unsaturated porous materials and recent instrumentation techniques are briefly reviewed. A numerical solution of the differential flow equation is outlined and its application to finite depth problems is discussed. (See also W71-03401) (Knapp-USGS)  
W71-03405

**ON SUBSIDENCE OF LOESS SOILS OF THE UKRAINE,**  
Akademiya Nauk UkrSSR, Kiev. Instytut Geologichnykh Nauk.

V. F. Kravev.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 321-324, 1970. 4 p.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Mining, Pumping, Soil mechanics, Rock mechanics, Water wells.

About 14% of the territory of the USSR and nearly 65% of the Ukraine are covered with loess. Loess has several specific compositional features (predominance of dust fractions, presence of carbonates, poor weathering of the clastogenic material) as well as specific properties (fast loosening, rather high filtration rate, anisotropy of the mechanical properties in vertical and horizontal directions), which cause subsidence. Subsidence is among the most adverse features of loess soils. Experience in the construction and operation of buildings on loess soils furnishes numerous exam-

ples of deformation suffered by buildings, industrial installations, and irrigation canals. In several areas of the Ukraine subsidence may be as great as 1.0 to 1.5 meters, with thickness of the loess averaging 20 to 40 meters. Subsidence results both from soaking of the soils from the top and from rise in the groundwater level following flooding of reservoirs. The physical nature of the phenomenon consists in a highly perceptible process of compaction of otherwise insufficiently compact portions of the loess complex due to disintegration of a greater part of structural bonds in the soil by water (or other liquids), which may be both natural or supplemented by the construction weight. (See also W71-03148) (Knapp-USGS)  
W71-03406

#### CONSIDERATION ABOUT THE COMPACTION MECHANISM OF STRATUM LYING AT THE DEEPER HORIZON IN TOKYO LOWLAND,

Hiroaki Univ. (Japan). Dept. of Pedagogics.

Tetsuro Shiobara.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 315-321, 1970. 7 p, 3 fig.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Hydrogeology, Clays, Aquicluides.

Identifiers: \*Tokyo (Japan).

A concept of 'Detour Traveling' is introduced to describe behavior of groundwater and intergranular water within pores of semi-pervious strata or aquicluides undergoing compaction. The Quaternary sediments in the Tokyo Lowland, especially the sediments at deeper horizon, are heterogeneous and frequently discontinuous, and the situation strongly regulates the 'Detour Traveling' effect. The deeper strata account for the greater part of the compaction. The change of groundwater pressure causes ground subsidence. It may be attributed to the compaction of a loose clayey material and to 'Detour Traveling' which expresses the effect of the water flow from the strata and the pressure propagation through the extending 'Arterial Network' of more porous materials. (See also W71-03148) (Knapp-USGS)  
W71-03407

#### SOME PROBLEMS OF TIME-SOIL COMPACTION IN PUMPING LIQUID FROM A BED,

All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR). Z. G. Ter-Martirosyan, and V. I. Ferronsky.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 303-314, 1970. 12 p, 4 fig, 14 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Mining, Pumping, Soil mechanics, Rock mechanics, Water wells, Mathematical studies, Hydrogeology.

Identifiers: \*USSR.

One-dimensional and plane axi-symmetrical problems of bed consolidation affected by the weight of overlying formations with different schemes of pumping are solved for the most general case when the bed from which a liquid (oil, water) is pumped is a deformed elastic-creeping porous medium filled with a compressible liquid. The mixture of liquid and gas is taken as a compressible liquid. Soil compaction due to the formation of a cone of depression is also discussed. (See also W71-03148) (Knapp-USGS)  
W71-03408

#### LAND SUBSIDENCE, EARTH FISSURES AND GROUNDWATER WITHDRAWAL IN SOUTH-CENTRAL ARIZONA, U.S.A.,

Geological Survey, Phoenix, Ariz.; and Geological Survey, Sacramento, Calif.

H. H. Schumann, and J. F. Poland.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 295-302, 1970. 8 p, 5 fig, 9 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Hydrogeology, Arizona.

Identifiers: \*Pinal County (Ariz.).

Land subsidence in western Pinal County, south-central Arizona, is related to groundwater withdrawal and resultant water level declines. Differential subsidence and earth fissures have damaged irrigation systems, interstate highways, and railroads; and have necessitated rerouting of a proposed aqueduct. Subsidence was first detected in 1948. The maximum documented subsidence from 1948 to 1967 is 2.30 meters. Large-scale pumping for irrigation from wells that penetrate as much as 700 meters of permeable sediments has lowered water levels as much as 61 meters. Net water-level declines correspond with subsidence and water-level fluctuations correlate with sediment compaction and expansion. Measured compaction, 1965-1967, in the upper 253 meters accounts for only 65 percent of measured subsidence. Numerous earth fissures, as much as 12.8 kilometers long, occur in the alluvium and transect natural drainageways. Some of the fissures appear on the periphery of the subsiding areas and may be tensional breaks. (See also W71-03148) (Knapp-USGS)  
W71-03409

#### LAND SUBSIDENCE AND AQUIFER-SYSTEM COMPACTION, SANTA CLARA VALLEY, CALIFORNIA, USA,

Geological Survey, Sacramento, Calif.

J. F. Poland.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 285-294, 1970. 10 p, 5 fig, 10 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Hydrogeology, Confined water, California.

Identifiers: \*Santa Clara Valley (Calif.).

Intensive withdrawal of groundwater from the confined aquifer system 240 m thick, in the San Jose area of Santa Clara Valley, California, has drawn down the artesian head as much as 75 m since 1912. Resulting land subsidence, which began about 1915, was 3.9 m in 1967. Periodic leveling of bench marks, core-hole data, and continuous measurements of water-level change and aquifer-system compaction furnish quantitative evidence on the response of the system to change in applied stress. The adjusted subsidence-head decline ratio in San Jose for 1920-38 was about 1:10. This ratio can be utilized to estimate ultimate subsidence from subsequent head declines. Compaction records at some sites define the magnitude of excess pore pressures in aquitards; at one site, increasing artesian head by 14 m should stop the subsidence. (See also W71-03148) (Knapp-USGS)  
W71-03410

#### FIELD MEASUREMENT OF AQUIFER-SYSTEM COMPACTION, SAN JOAQUIN VALLEY, CALIFORNIA, USA,

Geological Survey, Sacramento, Calif.

Ben E. Lofgren.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 272-284, 1970. 13 p, 11 fig, 4 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Hydrogeology, Surveys, California.  
Identifiers: \*San Joaquin Valley (Calif).

Two types of field measurements have been successfully used to monitor aquifer-system compaction and accompanying land subsidence in California: (1) periodic leveling of a network of surface bench marks, referenced to distant stable bedrock, and (2) continuous recording of vertical shortening of the water-bearing deposits, using extensometers installed in cased wells at selected locations. The compacting deposits of the aquifer system are readily compressible and sensitive to change in overburden stress. Imposed hydraulic stresses, caused by the extracting of fluids, results in immediate strain in the aquifer system. Both elastic compression and inelastic rearrangement of the intergranular structure are caused by a stress increase; however, the elastic expansion during a stress decrease is small compared to ultimate plastic compaction for a comparable stress increase. The subsidence/stress-change ratio ranges from 0.005 to 0.10 feet of subsidence per foot of hydraulic stress change during the first prolonged cycle of water-level decline. (See also W71-03148) (Knapp-USGS)  
W71-03411

#### ON THE VARIATION OF ARTESIAN HEAD AND LAND-SURFACE SUBSIDENCE DUE TO GROUNDWATER WITHDRAWAL, Saitama Univ., Urawa (Japan).

L. J. Tison.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 242-249, 1970. 8 p, 6 fig.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Mining, Pumping, Soil mechanics, Rock mechanics, Water wells.  
Identifiers: \*Yokkaichi (Japan).

In and near Yokkaichi, Japan observation of artesian head and subsidence has been carried out since August 1963. The secular variation of groundwater and land-surface levels is disturbed by oceanic tides, meteorological effects and other factors with periods of about one day or less. In order to obtain the secular variation, these disturbances were eliminated from observed data by Pertzev's method. Secular variation of both the groundwater and the land-surface levels is subject to the influence of groundwater withdrawal. The effective amount of discharge  $Q$  was calculated by means of the Theis recovery method. There is a good correlation between  $Q$  of one day and the secular value of the groundwater level at 06.00 hours of each following day. There is also a good correlation between  $Q$  and the amount of expansion-compaction. (See also W71-03148) (Knapp-USGS)  
W71-03412

#### SOME PROBLEMS AND RESULTS OF LABORATORY AND FIELD INVESTIGATIONS INTO ROCK MOVEMENTS CAUSED BY WATER MIGRATION IN LOOSE GRANULAR GROUNDS IN HUNGARY, Hungarian Mining Research Inst., Budapest.

Zs. Kesseru.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 249-255, 1970. 7 p, 2 fig, 8 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, \*Mining, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Analog models, Hydrogeology.  
Identifiers: \*Hungary.

Some observations are presented on the effect of water migration in loose granular rocks upon the compaction of aquifers based upon recent theoretical research work performed in Hungary. Measuring and estimating rock movements caused by pore water pressure drop in the vicinity of Gyon-gyosvisonta open pit mine were used for forecasting rock movement in the neighborhood of a thermal power-station and determining the constants necessary for calculating the reduction in porosity caused by secondary consolidation. Laboratory experiments were used for investigating rock movements caused by water migration in loose granular sedimentary rocks. Magnetic photoelastic analog modeling and triaxial filter cells were used for investigating the basic phenomena of rock equilibrium. (See also W71-03148) (Knapp-USGS)  
W71-03413

#### INFLUENCE OF SUBSIDENCE ON BOTH SURFACE AND UNDERGROUND HYDROLOGY (FRENCH), Ghent Rijksuniversiteit (Belgium).

L. J. Tison.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 242-249, 1970. 8 p, 6 fig.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.  
Identifiers: \*Land subsidence-streamflow relationships.

The influence of land subsidence on a river is discussed. The discharge of a river usually does not change under the influence of land subsidence. The theorem of the 'surface slope' shows that the absolute water levels are reduced in the zone of subsidence and upstream. However, the reduction of the absolute water level in the zone of subsidence is smaller than the amount of the subsidence and there is therefore a relative rising of the water level. In the case of floods, it is shown that the discharge of the river increases under the influence of subsidence with the following consequences: increase of the water level in the region of subsidence; increase of the absolute water levels downstream of the subsidence but decrease upstream. Debris and silt have more opportunity to deposit in the region of the subsidence. (See also W71-03148) (Knapp-USGS)  
W71-03414

#### GEOLICAL AND GEHYDROLOGICAL PROPERTIES OF THE LAND SUBSIDED AREAS-CASE OF THE NIIGATA LOW LAND, Ministry of Agriculture and Forestry, Niigata (Japan). Hokuriku Regional Office.

S. Takeuchi, S. Kimoto, M. Wada, H. Shiina, and K. Mukai.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 232-241, 1970. 10 p, 10 fig, 1 tab, 5 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Radioactive dating, Hydrogeology.  
Identifiers: Niigata (Japan).

To trace the origin of the land subsidence in the low-land area in Niigata Prefecture, Japan, geological and geohydrological properties of the subsided area were studied. The tests used included micropaleontological analysis, absolute chronology by the radiocarbon method, tritium dating, penetration tests, and exploratory boring. The land subsidence had a close relationship with the chronology and depositional environment of alluvium, and the groundwater was rather old. Land subsidence can be calculated in terms of hydraulic balance of groundwater. (See also W71-03148) (Knapp-USGS)  
W71-03415

#### WATER BALANCE INVESTIGATION BASED UPON MEASUREMENTS OF LAND SUBSIDENCE CAUSED BY GROUNDWATER WITHDRAWAL, District Water Authority, Pecs (Hungary).

I. Orloci.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 224-232, 1970. 9 p, 5 fig.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Hydrogeology, Porosity.  
Identifiers: \*Debrecen (Hungary).

The total water demand of Debrecen, Hungary is supplied from wells tapping a 20-30 m thick coarse sand aquifer of the lower Quaternary at 100-200 m depth. The aquifer is overlain by a fluvial series topped by loess and sand. The first wells were drilled some 70 years ago. The yearly water withdrawal now exceeds 12 million cu m. The piezometric level of this aquifer in the vicinity of the wells has subsided 15-20 m since 1913. Because of water withdrawal, the alluvial layer consolidates and the land subsides. Town survey data are used to compare old and recent measurements. A consolidation data series extending over about 40 years was obtained. The maximum subsidence of land amounts to over 40 mm since 1927. The water balance of the aquifer can be characterized by parameters of the compaction and of the dynamic resource determined by land subsidence data. The maximum degree of compaction (which is equal to the pore volume variation produced by possible consolidation) can be estimated at 4-5% of the pore volume of the layer. (See also W71-03148) (Knapp-USGS)  
W71-03416

#### SIMULATION OF GROUNDWATER BALANCE AS A BASIS OF CONSIDERING LAND SUBSIDENCE IN THE KOTO DELTA, TOKYO, Tokyo Univ. (Japan). Faculty of Science. Soki Yamamoto, Isamu Kayane, Shigeru Aoki, and Seiatsu Fuji.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 1, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 215-224, 1970. 10 p, 4 fig, 2 tab, 7 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, \*Mathematical models, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells, Hydrogeology, Model studies, Computer programs.  
Identifiers: \*Tokyo (Japan), \*Koto Delta (Japan).

The major cause of land subsidence in the Koto Delta area, Tokyo is believed to be the heavy withdrawal of groundwater. The rate of subsidence is generally in accord with the rate of change in piezometric surface. To simulate the secular trend of groundwater levels, a two-dimensional diffusion

## Field 02—WATER CYCLE

### Group 2F—Groundwater

model of a groundwater basin was adopted. Extraction data and water level histories were collected for the delta area and coefficients of storage and transmissibility were determined by the method of least squares using a digital computer. Most of the pumped groundwater in this area has been supplied not from the recharged groundwater but from that stored in the aquifer. (See also W71-03148) (Knapp-USGS)  
W71-03417

**GROUND SINKING IN SHIROISHI PLAIN, SAGA PREFECTURE,**  
Ministry of Agriculture and Forestry, Tokyo (Japan). Kanto Regional Office.  
Hisao Kumai, Mitsu Sayama, Tatsuo Sibasaki, and Kazuharu Uno.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 645-657, 1970. 13 p, 10 fig, 6 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.  
Identifiers: \*Japan.

Shiroishi Plain, Japan, is a deltaic plain of about 8 sq km on the Ariake sea. More than 150 deep wells which have been drilled since 1939 can supply water for irrigation. Wells have a depth ranging from 100-200 m and lift confined groundwater in deposits consisting of complex interfingered silt and gravel beds. The groundwater level declined very fast, and intrusion of saline water and ground sinking occurred. Zonal subsidence was found in this area in 1958 and occurred by the consolidation of alluvial clay. The sinking was found in the whole area of the plain in 1961. Sinking is about 20 cm/year maximum. It is directly proportional to the thickness of alluvial clay and volume of water withdrawn for irrigation. (See also W71-03148) (Knapp-USGS)  
W71-03418

**EXPERIMENTS ON WATER INJECTION IN THE NIIGATA GAS FIELD,**  
Geological Survey of Japan, Tokyo.  
Yasufumi Ishiwada.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 629-634, 1970. 6 p, 3 fig.

Descriptors: \*Withdrawal, \*Natural gas, \*Injection wells, \*Secondary recovery (Oil), \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.  
Identifiers: \*Niigata gas field (Japan).

Experiments using water injection in the natural gas reservoirs of 'dissolved-in-water type' (confined aquifers with dissolved methane gas) were carried out in Niigata City, Japan from 1960 to 1963. The purpose was to study field practice of water injection aimed at the maintenance of the reservoir pressures. Both degassed formation water drained from a gas-water separator and surface water taken from a river were used for injection fluids. Permeability of the main reservoirs ranges from 10 to 50 darcys. Injectivity index is, in general, less than a quarter of productivity index. Back-washing at adequate time intervals is necessary to continue long-term injection. (See also W71-03148) (Knapp-USGS)  
W71-03419

**PREDICTION OF FUTURE SUBSIDENCE ALONG DELTA-MENDOTA AND SAN LUIS**

**CANALS, WESTERN SAN JOAQUIN VALLEY, CALIFORNIA,**  
Bureau of Reclamation, Sacramento, Calif.

N. Prokopovich.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 600-610, 1970. 11 p, 10 fig, 12 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.  
Identifiers: \*Delta-Mendota Canal (Calif), \*San Luis Canals (Calif), \*San Joaquin Valley (Calif).

About 120 miles of the Delta-Mendota and San Luis Canals, California have been affected by subsidence caused by overdraft of groundwater. From 1905 to 1951 piezometric groundwater levels along the alignment declined up to 200 feet. Canal deliveries stopped the overdraft, but continuing readjustment of pore pressures caused some 'residual subsidence' to continue at gradually diminishing rates. The subsidence has affected the downstream 35-40 miles of the canal, locally exceeding 6 feet from 1953 to 1966. Estimates of ultimate future subsidence, varying from traces to 3.6 feet, were derived from bench mark data treated as an exponential decay function. About 80 miles of the San Luis Canal, constructed in 1963-67, are subsiding due to groundwater overdraft. From 1905 to 1962, piezometric levels along the alignment declined up to 470 feet, causing up to 18 feet of subsidence. Hydrocompaction of low-density sediments above the water table occurs in two portions of the San Luis Canal. The phenomena may be related to freezing swelling and following freeze-drying of Pleistocene mudflows. Ultimate amounts of hydrocompaction ranging from traces to 20 feet were calculated from average dry densities of sediments and 'ultimate' density values obtained in a few long-flooded areas. (See also W71-03148) (Knapp-USGS)  
W71-03420

**AN EXAMPLE OF GROUND SUBSIDENCE ESTIMATION,**

Public Works Research Inst., Tokyo (Japan).  
Masami Fukuoka.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 595-599, 1970. 5 p, 3 fig, 1 tab.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.  
Identifiers: \*Tokyo (Japan).

The Koto delta area of the Tokyo Metropolis is a low alluvial land extending for about 5 km from east to west, about 10 km from south to north, with an area of approximately 40 sq km bordered by the River Sumida on the west, and by the Arakawa canal on the east. An external embankment was planned for the purpose of defending this area from flood tide. Before carrying out this undertaking, the estimation of future sinking was necessary. Data available for the estimation were not sufficient. Accordingly, sinking for about 20 years after 1955 was estimated. The estimated amount of sinking was based on the following assumptions: (1) As an initial condition, the water level in the permeable sublayer in the alluvial layer and that in the middle permeable sublayer in the tertiary layer coincide; (2) All of the material in the compacted sublayer in the Alluvium is consolidated clay; (3) As the result of excessive pumping of underground water from the middle permeable stratum in the tertiary layer, the ground sank because of consolidation in the middle clayey sublayer in the Alluvium as well as in the middle permeable stratum of the tertiary layer

located at depths of up to 80 m; (4) Where the water level in the middle permeable stratum fell below the lower face of the alluvial layer, atmospheric pressure was effective between the lower face of alluvial layer and the water table. Because the void ratio, unit weight, compression index and coefficient of consolidation before the ground subsidence were not available, the soil constants acquired by testing of samples obtained from cores were used without adjustment. (See also W71-03148) (Knapp-USGS)  
W71-03421

**ANALYTICAL METHODS FOR PREDICTING SUBSIDENCE,**  
Woodward-Clyde-Sherard and Associates, Oakland, Calif.  
Keshavan Nair.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 588-595, 1970. 8 p, 3 fig, 20 ref.

Descriptors: \*Numerical analysis, \*Subsidence, \*Land subsidence, \*Mining, Mathematical studies, Compaction, Damages, Groundwater, Groundwater movement, Soil mechanics, Rock mechanics, Water wells.  
Identifiers: \*Finite element analysis.

The finite element technique is considered to be the most useful technique for application to subsidence problems. This paper deals solely with the problem of subsidence which is a consequence of the creation of underground openings. Analytical methods based on the principles of solid mechanics and placed within the framework of a good understanding of the physical nature of the problem have proved to be the most useful means for developing predictive techniques for engineering problems. The major variables that have to be included in formulating a problem for investigating subsidence are: (1) location of the underground opening; (2) shape of the opening; (3) the rock profile and geologic conditions; (4) the properties of the rock mass surrounding the opening, and (5) the initial state of stress in the rock. (See also W71-03148) (Knapp-USGS)  
W71-03422

**A THEORETICAL APPROACH TO STRESS-STRAIN RELATIONS OF CLAYS,**  
Kyoto Univ. (Japan). Dept. of Civil Engineering.  
Shojoji Hata, Hideki Ohta, and Sudumu Yoshitani.  
In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 563-572, 1970. 10 p, 6 fig, 8 ref.

Descriptors: \*Subsidence, \*Land subsidence, \*Clays, \*Consolidation, Aquifers, Compaction, Damages, Groundwater, Groundwater movement, Soil mechanics, Rock mechanics, Water wells, Shear, Strength of materials, Deformation, Elastic theory, Rheology.  
Identifiers: \*Stress-strain analysis (Clays).

The derivations of the stress-volumetric strain relations for normally and overconsolidated clays are described. The volume change of clays caused by a change in the stress state of clay elements consists of two components; one is the consolidation component that is induced by the change of hydrostatic pressure and the other is the dilatancy component which accompanies the deformation of clay elements. The two components of volume change (consolidation and dilatancy) are not necessarily independent of each other; therefore the total volume change induced by the stress change is not necessarily equal to the summation of consolidation and dilatancy. (See also W71-03148) (Knapp-USGS)  
W71-03423

**WATER PERMEABILITY AND PLASTIC INDEX OF SOILS,**  
Kanazawa Univ. (Japan). Dept. of Engineering.

Yoshichika Nishida, and Seishi Nakagawa.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 573-578, 1970. 6 p, 3 fig, 1 tab.

Descriptors: \*Permeability, \*Plasticity, Clays, \*Rheology, \*Subsidence, Aquifers, Seepage, Infiltration, Compaction, Groundwater, Groundwater movement, Soil mechanics, Rock mechanics, Water wells, Plasticity index.

Identifiers: \*Permeability (Clays).

The coefficient of permeability of water in clay, on which the rate of consolidation settlement is dependent, can be approximately calculated from its void ratio and plastic index through a simple formula. A linear relationship was experimentally determined relating void ratio of a clay and the logarithmic value of its coefficient of permeability. (See also W71-03148) (Knapp-USGS)

W71-03424

#### RELATIONSHIP OF CONSOLIDATION CHARACTERISTICS AND ATTERBERG LIMITS FOR SUBSIDING SEDIMENTS IN CENTRAL CALIFORNIA, U.S.A., Geological Survey, Denver, Colo. Water Resources Div.

A. I. Johnson, and R. P. Moston.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 579-587, 1970. 9 p, 5 fig, 1 tab, 1 ref.

Descriptors: \*Plasticity, \*Rheology, \*Consolidation, \*Clays, \*Subsidence, California, Land subsidence, Aquifers, Liquid limits, Atterberg limits, Plasticity index, Seepage, Infiltration, Compaction, Groundwater, Groundwater movement, Soil mechanics, Rock mechanics, Water wells.

Identifiers: \*San Joaquin Valley (Calif.).

As one phase of research on land subsidence, laboratory analyses were made on many undisturbed cores obtained from sediments in subsiding areas of Central California. In 1948 Terzagi and Peck had presented equations relating compression index or coefficient of consolidation to liquid limit, but present research indicates that the same relationships do not hold for any of the sediments tested from Central California. The compression index could be estimated from liquid-limit data, but the relationship was different for each area of subsidence. Comparison of compression indices obtained from consolidation curves with indices computed from liquid limits showed better correlation for sediments of alluvial and lacustrine origin than for sediments of marine origin. Equations for the relationships were obtained by computer solution of data trends. In all three areas of subsidence, the coefficient of consolidation showed a general decrease for increasing values of liquid limit. However, the relationship could not be estimated with reasonable accuracy because the coefficient for any particular load range could vary through more than one order of magnitude for any given liquid limit. (See also W71-03148) (Knapp-USGS)

W71-03425

#### VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER, Kyoto Univ. (Japan). Disasters Prevention Research Inst.

Yoshiaki Fukuo.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 547-562, 1970. 16 p, 4 fig, 6 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, \*Rheology, \*Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.

Pumping, Soil mechanics, Rock mechanics, Water

wells, Non-Newtonian flow, Plasticity, Viscosity, Confined water.

Identifiers: Japan.

The dynamic theory for the deformation of a granular solid saturated with a liquid, is derived assuming that the liquid filling up the pore space is a Newtonian viscous fluid and the skeleton constituted by solid particles is a linear visco-elastic solid. The theory consists of three fundamental equations, the equations of motion of liquid and skeleton and the equation of continuity between the particles and liquid. In a case where the particle and liquid are taken to be incompressible and the deformation of soil is a quasi-static process, these equations are accepted as the theory of three-dimensional consolidation including Terzaghi's well-known equation as a special case, and are also recognized as the basic equations of motion of confined groundwater in a visco-elastic aquifer. A theoretical example shows rheological deformation of an infinite confined aquifer with uniform thickness caused by pumping up water at a constant rate. (See also W71-03148) (Knapp-USGS)

W71-03426

#### COMPRESSION OF THE PEAT-BOGS AFTER DRAINING,

A. I. Murashko.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 535-546, 1970. 12 p, 6 fig, 2 tab.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, \*Drying, \*Organic soils, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.

Identifiers: \*Byelorussia (USSR).

Peat-bogs cover one fourth of the total territory of Byelorussia, or 4.5 million hectares. 70-80 thousand hectares of bogs are drained annually in the Republic for agricultural purposes. Peat compression results in diminishing of drain and canal depths, deformation of canal sections, and alternation of slopes of drain lines and relief. Methods are described for calculating peat compression, developed from solution of the differential equations developed by the author and utilization of data of long-term experiments. Formulas take into account thickness of peat layer and its density, characteristics of draining net system and duration of draining. They make it possible to calculate peat compression at any point of a peat-bog surface. (See also W71-03427) (Knapp-USGS)

W71-03427

#### SUBSIDENCE OF ORGANIC SOILS IN THE U.S.A.,

Agricultural Research Service, Athens, Ga. Soil and Water Conservation Research Div.

John C. Stephens, and William H. Speir.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 523-534, 1970. 12 p, 5 fig, 17 ref.

Descriptors: \*Subsidence, \*Withdrawal, \*Land subsidence, \*Drying, \*Organic soils, Aquifers, Water levels, Water table, Water balance, Surface-groundwater relationships, Seepage, Infiltration, Compaction, Damages, Groundwater, Groundwater movement, Pumping, Soil mechanics, Rock mechanics, Water wells.

Identifiers: \*Everglades (Fla.).

Organic soils subside when drained by shrinkage from drying, loss of groundwater buoyancy, compaction, wind erosion, burning, and biochemical oxidation. Relative loss due to each causative factor depends on soil origin, climate, and land management. Shrinkage rate is proportionate to drainage depth—the lower the water table, the

greater the subsidence. Level surveys at 5-year intervals from 1913 to 1968 have established the pattern of subsidence in the Florida Everglades to be initially rapid, mainly from shrinkage and compaction, then declining to a continuous steady rate, primarily from oxidation until underlying mineral material is reached. Arable peats have average sinking rates of 3 cm per year. Predictive studies indicate that Everglades peats will be too shallow for agricultural use by 2,000 A.D. Under similar drainage, organic soils subside faster in warm climates, and lowmoor faster than highmoor peats. To conserve organic soils, water tables should be kept as high as crop and field requirements permit. (See also W71-03148) (Knapp-USGS)

W71-03428

#### PREDICTION OF HORIZONTAL MOVEMENTS DUE TO SUBSIDENCE OVER MINED AREAS, California Univ., Los Angeles. Dept. of Engineering.

Kenneth L. Lee, and Michael E. Strauss.

In: Proceedings of the Tokyo Symposium on Land Subsidence, Vol 2, International Association of Scientific Hydrology and UNESCO, September 1969, Tokyo, p 512-522, 1970. 11 p, 8 fig, 7 ref.

Descriptors: \*Subsidence, \*Land subsidence, \*Mining, Compaction, Damages, Groundwater, Groundwater movement, Soil mechanics, Rock mechanics, Water wells.

Identifiers: \*Mine subsidence.

Some interrelations between vertical and horizontal movements in ground subsidence problems are summarized. The finite element method of analysis is shown to give a good prediction of the correct nature and magnitude of both vertical and horizontal movements resulting from mining subsidence. Two key features which are essential in order for horizontal movements to develop along with vertical subsidence are: first, the seat of major settlement must be located at some significant depth below the ground surface; and second, there must be significant differential vertical movement across the subsiding area. In subsidence areas where horizontal movement data have been obtained, there is no horizontal movement at the point of maximum subsidence, nor are there any horizontal movements at considerable distances beyond the subsidence zone. At each location the direction of horizontal movement is toward the zone of maximum settlement. The point of maximum movement corresponds to the point of steepest slope of the vertical subsidence profile, and the horizontal strain at this point is zero. The horizontal strain over much of the central part of the subsidence area is compressive, and extension strains develop near the outer edges of the subsidence zone. The point of maximum horizontal strain is located at the point of steepest of the horizontal movement curve. (See also W71-03148) (Knapp-USGS)

W71-03429

#### GEOCHEMICAL STUDY OF GROUNDWATERS IN THE MATSUSHIRO AREA - PART 2: CHEMICAL COMPOSITION OF GROUNDWATERS,

Nagoya Univ. (Japan). Water Research Lab.

For primary bibliographic entry see Field 02K.

W71-03437

#### SUBSURFACE DISPOSAL OF LIQUID WASTES IN ONTARIO,

For primary bibliographic entry see Field 05E.

W71-03438

#### SEISMIC REFRACTION AND ELECTRICAL RESISTIVITY: TOOLS IN GROUNDWATER EXPLORATION,

Iowa State Univ., Ames. Dept. of Earth Science.

For primary bibliographic entry see Field 07B.

W71-03439

## Field 02—WATER CYCLE

### Group 2F—Groundwater

**GROUNDWATER THERMAL REGIME IN A GLACIAL COMPLEX,**  
Department of Energy, Mines and Resources, Ottawa (Ontario). Inland Waters Branch.  
Myles L. Parsons.  
Water Resources Research, Vol 6, No 6, p 1701-1720, December 1970. 10 fig, 30 ref.

Descriptors: \*Groundwater, Heat transfer, \*Temperature, Hydrologic properties, Depth, Thermal conductivity, Mathematical models, Isotherms, Flow, \*Glaciers, Glacial soils.  
Identifiers: \*Thermal regime, Surface cover.

A simple generalized model of a groundwater thermal regime is examined to develop insight into hydrologic and thermal framework. Numerical simulation of the groundwater thermal regime in a glacial complex in the northern Ontario clay belt and numerical modeling of a hypothetical groundwater basin suggest that groundwater flow has a significant effect on the subsurface temperature field. Borehole temperature measurements reflect the hydrogeologic contrast between the highly permeable eskerine deposits and the adjacent less permeable clay and till strata. The eskerine groundwater is several degrees warmer and possesses lower spatial temperature variations than does the clay-till groundwater. Numerical simulation of the temperature field indicates that the temperature variations are related to differences in thermal conductivities of the flow media, to variations in the magnitude of the groundwater flux between esker and clay-till flow systems, and to spatial variations in the water table temperature. The latter factor probably reflects contrasting surface cover conditions between the sandy eskerine terrain and the organic terrain of the clay plain. Contains 30 references. (Upadhyaya-Vanderbilt)  
W71-03464

**RELATIONSHIP BETWEEN HORIZONTAL STRAIN NEAR A WELL AND REVERSE WATER LEVEL FLUCTUATION,**  
Geological Survey, Washington, D.C.

Roger G. Wolff.

Water Resources Research, Vol 6, No 6, p 1721-1728, December 1970. 8 p, 8 fig, 11 ref.

Descriptors: \*Water level fluctuations, \*Strain, \*Compaction, Subsidence, Porosity, Clays, Withdrawal, Shear stress, Hydraulic conductivity, Aquifers, Aquiclude, Pore pressure.  
Identifiers: Pore pressure fluctuations.

Measurements of radial surface strains near a pumping well showed compression near the well that changed to tension farther away from the well. A theoretical model is presented. In general, this model reproduces the measured strains. Observations of anomalous increase in pore pressure in a clay adjacent to the pumped aquifer are related to the development of these strains. These increases in pressure are attributed to distortion of the pore space in the clay resulting from the transference of horizontal strain from the aquifer via shear. Applying a conceptual model that permits the transference of strain across confining layers to unpumped artesian aquifers accounts for reverse water level fluctuations. (Knapp-USGS)  
W71-03686

**SOURCES OF DISSOLVED CARBONATE IN AN AQUIFER FREE OF CARBONATE MINERALS,**  
Geological Survey, Washington, D.C.; Geological Survey, Denver, Colo.

For primary bibliographic entry see Field 02K.  
W71-03694

**THE ALASKAN EARTHQUAKE, MARCH 27, 1964: LESSONS AND CONCLUSIONS,**  
Geological Survey, Washington, D.C.  
For primary bibliographic entry see Field 02E.  
W71-03706

## 2G. Water in Soils

**SEEPAGE IN MISSISSIPPI RIVER BANKS; REPORT 1, ANALYSIS OF TRANSIENT SEEPAGE USING VISCOSITY FLOW MODEL AND NUMERICAL METHODS,**  
Army Engineer Waterways Experiment Station, Vicksburg, Miss.  
For primary bibliographic entry see Field 04A.  
W71-03320

**THE USE OF SOIL WATER BALANCE RELATIONSHIPS IN AGROCLIMATOLOGY,**  
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.  
For primary bibliographic entry see Field 02D.  
W71-03346

**ONE-DIMENSIONAL GROUNDWATER RECHARGE,**  
New South Wales Univ. Kensington (Australia). School of Civil Engineering.  
For primary bibliographic entry see Field 02F.  
W71-03405

**ON SUBLIMATION OF LOESS SOILS OF THE UKRAINE,**  
Akademiya Nauk URSR, Kiev. Instytut Geologichnykh Nauk.  
For primary bibliographic entry see Field 02F.  
W71-03406

**A THEORETICAL APPROACH TO STRESS-STRAIN RELATIONS OF CLAYS,**  
Kyoto Univ. (Japan). Dept. of Civil Engineering.  
For primary bibliographic entry see Field 02F.  
W71-03423

**WATER PERMEABILITY AND PLASTIC INDEX OF SOILS,**  
Kanazawa Univ. (Japan). Dept. of Engineering.  
For primary bibliographic entry see Field 02F.  
W71-03424

**STRATIGRAPHY, SEDIMENTOLOGY, AND MOISTURE CONTENTS IN A SMALL LOESS WATERSHED IN TAMA COUNTY, IOWA,**  
Iowa State Univ., Ames. Dept. of Agronomy.  
W. J. Vreeken.

Iowa Academy of Science Proceedings, Vol 75, p 225-233, 1968. 9 p, 5 fig, 1 tab, 2 ref. OWRR Project A-014-IA (2).

Descriptors: \*Loess, \*Erosion, \*Soil water, \*Moisture tension, Sedimentation, Particle size, Particle shape, Sampling, Iowa, Hydrogeology, Soil physical properties.  
Identifiers: Tama County (Iowa).

Particle-size analyses performed on many samples along a traverse across a first-order watershed in loess and integrated into a lithological profile show a clear vertical tripartition in the loess. Distinct stratification in the middle loess increment is shown by sand lenses and differences in silt fractions. Strong beveling of the strata in the south-facing slope indicates that this slope has experienced a higher rate of erosion than did the north-facing slope. Comparison of the lithological analysis with moisture distributions at different times within a one-year period shows a close relationship between particle-size distribution and moisture content. The explanatory physical phenomena must be moisture-tension relationships. (Knapp-USGS)  
W71-03440

**ORTHONORMAL FUNCTION TABLES AND THE SEEPAGE OF STEADY RAIN THROUGH SOIL BEDDING,**  
Iowa State Univ., Ames.

W. L. Powers, Don Kirkham, and G. Snowden. Journal of Geophysical Research, Vol 72, No 24, p 6225-6237, December 15, 1967. 13 p, 6 fig, 5 tab, 9 ref. OWRR Project B-002-IA (7).

Descriptors: \*Soil water movement, \*Groundwater movement, \*Seepage, \*Flow nets, Drainage, Saturated flow, Mathematical studies, Furrow drainage, Furrow irrigation, Data processing, Numerical analysis.  
Identifiers: \*Computer techniques.

Tables of functions are developed for generating, with the aid of a digital computer, sets of general orthonormal functions useful in solving some potential flow problems. As an example of the use of the tables, a flow problem of seepage of groundwater through soil bedding (which is a series of formed parallel mounds and depressions used in land drainage design when soil overlies an impermeable layer) is solved. Flow nets are presented for a number of geometries for the bedding problem. It is noted that the bedding problem corresponds to the problem of seepage of groundwater into a shallow river between sloping hillsides when horizontal bedrock underlies the river valley. (Knapp-USGS)  
W71-03441

**EXPLANATION OF PARADOXES IN DUPUIT-FORCHHEIMER SEEPAGE THEORY,**  
Iowa State Univ., Ames. Dept. of Agronomy.  
Don Kirkham.

Engineering News, Vol 12, No 1, p 22-39, March 1967. 18 p, 10 fig, 29 ref. OWRR Project B-002-IA (6).

Descriptors: \*Dupuit-Forchheimer theory, \*Soil water movement, \*Groundwater movement, Darcys law, Permeability, Anisotropy, Water levels, Drawdown, Percolation, Infiltration, Drainage, Seepage.  
Identifiers: \*Seepage theory.

Cutting into a porous medium of a large number of vertical, parallel, infinitely permeable, equally spaced, infinitesimally thin slots produces a fictitious soil that follows exactly and without paradoxes Dupuit's assumptions and hence Dupuit-Forchheimer (D.F.) drainage theory in two dimensions. A soil having these infinitesimally thin slots is designated a D.F. soil. Dupuit's two-dimensional 'parabolic seepage problem' and others, may now be considered as exactly solvable for D.F. soils. For three-dimensional axially symmetric seepage flow, as into wells, the fictitious slots of a D.F. soil become concentric coaxial rings. D.F. streamlines are not horizontal; they converge in a special way. Some differences between the behavior of D.F. soils and real soils are: (1) D.F. theory gives too low a water table, that is, drain spacings must be closer than D.F. theory gives to establish a given water table height; (2) D.F. theory gives a better approximation for flow into ditches than into tiles; (3) D.F. theory fails completely (gives infinite drain spacings) when the impermeable layer is at infinite depth; (4) streamlines in a D.F. soil converge to a plane vertical outflow surface or to a cylindrical vertical outflow surface; and (5) the equipotentials and streamlines in D.F. theory comprise a non-orthogonal flow net. (Knapp-USGS)  
W71-03442

**FRACTIONATION OF PHOSPHATE IN A MATURITY SEQUENCE OF NEW ZEALAND BASALTIC SOIL PROFILES: I,**  
Lincoln Coll., Canterbury (New Zealand).  
J. D. H. Williams, and T. W. Walker.  
Soil Science, Vol 107, No 1, January 1969, p 22-30. 2 tab, 1 fig, 24 ref.

Descriptors: \*Phosphates, \*Soil profiles, \*Soil chemical properties, \*Weathering, \*Basalts,

Leaching, Soil water, Calcium, Equilibrium, Phosphorous, Ammonium salts, Sodium compounds, Sierozems, Soil horizons, Iron, Aluminum, Mineralogy, Sampling, Variability.  
Identifiers: \*Fractionation, \*Maturity sequence, \*New Zealand, \*Occlusion, Chang-Jackson procedures.

Inorganic phosphate in 62 horizons from 16 New Zealand basaltic soils varying in weathering and leaching degree was fractionated and studied. Acid-extractable Ca-P declined, and NH sub 4 F-P increased and then declined with increased weathering. Reductant soluble P, secondary NaOH-P and residual inorganic P increased. First NaOH-P fraction showed no trend. Fractions, particularly NH sub 4 F-P, reflected soil mineralogy. Iron- and aluminum-bound phosphate fractions were consistent with the theory that these categories in freely-drained unfertilized soil consist of phosphate ions randomly retained in non-occluded or occluded form by Fe- and Al-containing soil. This implies that no absolute distinction can be drawn between categories, and that the arbitrariness of Chang and Jackson-type procedures is further increased when occluded Al-bound phosphate is present. A sequential paper (Soil Science, Vol. 107, No. 3) proposes 'maturity sequence' related to generalized weathering sequence and equilibrium with soil water. Tables show phosphate fraction values and mean values for several properties. (See also W71-03483) (Popkin-Arizona)  
W71-03482

FRACTIONATION OF PHOSPHATE IN A MATURITY SEQUENCE OF NEW ZEALAND BASALTIC SOIL PROFILES: 2, Lincoln Coll., Canterbury (New Zealand). J. D. H. Williams, and T. W. Walker. Soil Science, Vol 107, No 3, March 1969, p 213-219. 2 tab, 4 fig, 11 ref.

Descriptors: \*Phosphates, \*Soil profiles, \*Soil chemical properties, \*Basalts, \*Weathering, Leaching, Soil water, Equilibrium, Phosphorous, Ammonium salts, Sierozems, Soil horizons, Mineralogy.  
Identifiers: \*Fractionation, \*Maturity sequence, \*New Zealand, \*Occlusion, Chang-Jackson procedures, Apatite, Pedogenesis.

Changes in relative amounts of phosphate in apatite, organic phosphate, and non-occluded and occluded forms of secondary inorganic phosphate during pedogenesis were illustrated by a 'maturity sequence' of 16 New Zealand basaltic soil profiles. Difficulties in defining these categories and in their measurement due to inadequacies in Chang and Jackson-type procedures are discussed. Mineralogical differences between and within soil profiles may partly account for the similarity in organic P and NH sub 4 F-P behavior within profiles, but the relationship also reflects equilibrium between organic phosphate and non-occluded forms of secondary inorganic phosphate. The hypothesis that phosphate in apatite is transformed into occluded phosphate by these forms accounted for distribution changes of phosphate between the fractions with increasing profile maturity. The generalized weathering sequence and equilibrium with soil water are considered. Tables show phosphate fraction profiles and nomenclature. Figures show mean values of Ca-P, and various P as percentage of total P, total inorganic P, phosphate fraction transformation in acid soils and phosphate fraction magnitude changes. (See also W71-03482) (Popkin-Arizona)  
W71-03483

THREE METHODS OF WATER CONSERVATION FOR DRYLAND COTTON PRODUCTION, Texas Agricultural Experiment Station, College Station.  
For primary bibliographic entry see Field 03F.  
W71-03487

#### STRAW MANAGEMENT-NITROGEN TREATMENT INVESTIGATIONS IN THE CONTINUOUS PRODUCTION OF IRRIGATED WINTER WHEAT,

Southwestern Great Plains Research Center, Bushland, Tex.  
For primary bibliographic entry see Field 03F.  
W71-03488

#### THE CHELATION AND MOVEMENT OF SR89-SR90 (Y90) IN A CALCAREOUS SOIL,

Arizona Univ., Tucson.  
Michael F. L'Annunziata, and Wallace H. Fuller. AEC AT (11-1)-947. Soil Science, Vol 105, No 5, May 1968, p 311-319. 3 tab, 10 fig, 27 ref.

Descriptors: \*Strontium radioisotopes, \*Chelation, \*Radioactive wastes, \*Calcareous soils, \*Leaching, Soil water movement, Arid lands, Electrophoresis, Radioactivity effects, Color reactions, Calcium, Hydrogen ion concentration, Assay, Stability, Structure, Soil chemistry, Sands, Loam, Southwest U.S., Distribution patterns, Radioisotopes.  
Identifiers: \*Synthetic chelates, \*Natural organic chelates, Phosphomolybdtungstic acid, HEEDTA, DCyTA, EDTA, EGTA, DTPA.

The influence of synthetic chelating agents on radiostrontium movement through soil with leaching was studied. Phosphomolybdtungstic acid (Folin-Ciocalteau Reagent) was an excellent indicator for chelons, producing a blue color with Nu sub 2 CO sub 3 addition. Color reaction and paper electrophoresis indicated the presence of radionuclide complexes in the soil solution as formed by synthetic chelates. Displacement of Sr 89 from columns of Mohave sandy loam was 19, 38, 44, 47 and 81 percent for HEEDTA, DCyTA, EDTA, EGTA and DTPA. Only 5 percent of the Sr 89 was leached in the absence of synthetic chelates. Natural organic chelates did not influence radiosstrontium movement. Tables of stability constants of chelates with Ca and Sr, leaching treatments and carboxyl, chelate and effectiveness of Sr movement interrelationships are presented. Figures show structural formulas; chelation of Ca with synthetic chelates; Sr 89 displacement, movement, percentage and profile distribution; electrophoresis of radiostrontium and displaced soil solution; and general chelating reaction. (Popkin-Arizona)  
W71-03495

#### CESIUM UPTAKE BY SUDANGRASS SEEDLINGS FROM FOUR SOILS IN SOUTHERN CALIFORNIA,

California Univ., Riverside. Dept. of Soils and Plant Nutrition.

For primary bibliographic entry see Field 02I.  
W71-03496

#### AN APPARATUS FOR LEACHING SOIL SAMPLES,

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research.

B. G. Williams. Soil Science, Vol 105, No 5, May 1968, p 376-377. 2 fig, 5 ref.

Descriptors: \*Leaching, \*Equipment, \*Infiltrometers, \*Permeameters, \*Infiltration, \*Permeability, Soil physics, Suspension, Hydraulic conductivity, Cation exchange, Tubes, Drainage water, Arid lands, Sampling, Filters, Flow control, Rates of flow.  
Identifiers: \*Intrinsic permeability, Reverse flow.

Leaching tests are important in determining soil properties in arid lands for agricultural and hydrologic studies. A soil leaching apparatus which controls colloidal material loss is described in this paper. Reverse flow of the extracting solution is the leaching method used. This results in partial suspension of the sample, free access of the solution to all soil particles and avoidance of fine particle packing. Leaching tubes are constructed from

'perspex.' Twelve tubes can be arranged to be fed from one manifold with individual stopcocks. A manifold tap reduces the flow when desired. Infiltration, hydraulic conductivity, intrinsic permeability, cation exchange capacity and effect of soil on drainage water may be measured with this apparatus. Two sketches of the leaching tube and apparatus are shown. (Popkin-Arizona)  
W71-03497

#### A SOIL AND VEGETATION PATTERN IN THE SANTA CATALINA MOUNTAINS, ARIZONA,

California Univ., Irvine; and North Carolina State Univ., Raleigh.

R. H. Whittaker, S. W. Buol, W. A. Niering, and Y. H. Havens. NSF grant. Soil Science, Vol 105, No 6, June 1968, p 440-450. 2 tab, 2 fig, 50 ref.

Descriptors: \*Soil texture, \*Mountains, \*Distribution patterns, \*Arizona, \*Vegetation, Soil-water-plant relationships, Mexico, Calcium, Magnesium, Potassium, Nitrogen, Biomass, Air temperature, Arid lands, Soil profiles, Elevation, Soil horizons, Slopes, Color, Depth, Sampling, Temperature, Topography, Organic matter, Plant populations, Biological communities, Ecosystems, Sierozems, Fluctuation, Thermocline, Desert plants.  
Identifiers: \*Santa Catalina Mountains (Arizona), \*Desert range, Carbon/nitrogen ratio, Topographic moisture gradient, Elevation gradient.

The Santa Catalina Mountains are a desert range in southeastern Arizona with Mexican affinities in their floras and faunas. Soil characteristics and temperatures and vegetation were studied in a transect across the Santa Catalinas. Trends of interrelated characteristics of plants and soils were observed from high to low elevations: decreasing productivity, biomass and coverage of plant communities; shifts in growth-form composition of communities; decreasing litter cover and organic soil content; increasing annual and diurnal amplitude of soil temperature; decreasing nitrogen content and C/N ratios of soils; increasing pH; and increasing Ca, Mg and K contents. Trends along the topographic moisture gradient paralleled these along parts of the elevation gradient. The elevation and topographic moisture gradients define a pattern of mountain ecosystems, comprising corresponding patterns of climatic and topographic environments, soils and plant communities. Tables show summary of measurements and profile descriptions. Figures show the pattern of plant communities to elevation and topography and soil characteristic trends to elevation. (Popkin-Arizona)  
W71-03498

#### SOIL SALINITY IN THE WEST CENTRAL GEZIRA, REPUBLIC OF THE SUDAN,

Australian National Univ., Canberra. Research School of Pacific Studies.

M. A. J. Williams. Soil Science, Vol 105, No 6, June 1968, p 451-464. 9 fig, 20 ref.

Descriptors: \*Saline salts, \*Salts, \*Clays, \*Soil texture, \*Arid lands, Rainfall, Topography, Drainage, Soil chemistry, Salinity, Dunes, Permeability, Evaporation, Electrical conductance, Subsoil, Soil horizons, Maps, Sampling, Depth, Distribution patterns, Sodium, Topsoil, Geomorphology, Surface drainage, Colluvium, Alluvium, Lake shores.  
Identifiers: \*Republic of the Sudan, \*West Central Gezira (Sudan), White Nile (Sudan), Closed depressions, Clay plains, Salinity controls, Extractable sodium, Exchangeable sodium.

Subsoil and topsoil salinity was mapped for 1.3 m. acres of land bordering the White Nile between Khartoum and Rabak, in the Sudan. Salt peaks in the second horizon except in the southern colluvial clays, where it increases with depth. Relationships between salinity and rainfall, soil texture, topography, drainage and soil chemical properties are discussed. Soils are saline in closed depressions and

## Field 02—WATER CYCLE

### Group 2G—Water in Soils

on the northern clay plains. Soils are non-saline on dunes, recent alluvial terraces and colluvial upland clays. Subsoil salinity is highest around former lake margins, and decreases with increasing elevation. Soil texture, permeability and topography are dominant salinity controls. Rainfall and evaporation have a minor influence on salt distribution in this area. Figures include physiographic and soil maps, topsoil and subsoil electrical conductivity distribution, soil class and electrical conductivity relations, relation between depth and salinity, exchangeable sodium and clay content relationships, and total extractable sodium and electrical conductivity relations. (Popkin-Arizona)  
W71-03499

**MORPHOLOGY OF THE ARGILLIC HORIZON IN DESERT SOILS OF SOUTHERN NEW MEXICO,**  
Soil Conservation Service, University Park, N. Mex.  
L. H. Gile, and R. B. Grossman.

Soil Science, Vol 106, No 1, July 1968, p 6-15. 2 tab, 7 fig, 15 ref.

Descriptors: \*Soil horizons, \*Sierozems, \*Clays, \*Geomorphology, \*New Mexico, Carbonates, Montmorillonite, Abrasion, Soil moisture, Energy, Animals, Root systems, Recent epoch, Pleistocene epoch, Calcium carbonate, Arid lands, Sands, Pedocals, Age, Geologic time, Soil types, Depth, Particle size, Soil profiles.

Identifiers: \*Argillie horizon, \*Authigenic carbonate, \*Illuviation, Clay skin.

The argillie horizon in a southern New Mexico desert is affected by authigenic carbonate, silicate clay and coarse fragments. Prominent horizons occur only in soils of Pleistocene age. Clay skins are not a requirement for an argillie horizon. Many oriented clay bodies are clay skin remnants formed on ped surfaces during Pleistocene pluvial periods and are evidence of an illuvial origin. Clay skins are found on ped surfaces in pipes of overthickened horizons in buried Pleistocene soils. These skins are evidence of clay Pleistocene illuviation. Clay skin preservation through Recent time requires restricted physical disturbance, though authigenic carbonate accumulation, shallowness of horizon and access by roots and fauna, high energy, moisture changes and montmorillonitic clay favor disturbance. Oriented clay coatings are typical of Bt horizons of the area. The coatings are strongly expressed in the silicate clay horizon and are markers of clay illuviation. Expression of argillie horizon is related to soil age, carbonate accumulation horizon, subjection to abrasion during moisture changes and other Pleistocene events. Tables show illustrative soils, geomorphic surfaces, ages and laboratory data for soils. (Popkin-Arizona)  
W71-03500

**QUANTITATIVE STUDIES OF ROOTS IN SOIL. I. LENGTH AND DIAMETERS OF COTTON ROOTS IN A CLAY-LOAM SOIL BY ANALYSIS OF SURFACE-GROUND BLOCKS OF RESIN-IMPREGNATED SOIL,**

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Irrigation Research Lab.

F. M. Melhuish, and A. R. G. Lang.

Soil Science, Vol 106, No 1, p 16-22, July 1968. 2 tab, 4 fig, 7 ref.

Descriptors: \*Root distribution, \*Soil-water-plant relationships, \*Resins, \*Soil water movement, \*Cotton, Soil water, Clay loam, Porosity, Pores, Probability, Analytical techniques, Sampling, Length, Surfaces, Measurement, Instrumentation, Plant growth, Voids, Mathematical studies. Identifiers: \*Derivation, Mean root surface area.

Distribution and measurement of the roots of a cotton plant grown in a drum of clay-loam soil are described in this paper. Core soil samples were oven-dried and vacuum impregnated with a ther-

mosetting polyester resin. Plane surfaces were prepared by surface grinding the cured samples. Root analysis was determined by measurement of voids left in the soil after drying and root shrinkage. A theoretical derivation based on geometrical probability of probable root length per unit soil volume from the numbers of roots intersecting a plane of known area was verified experimentally. The probable root length per unit volume and probable mean root surface area per unit volume were calculated. Root distribution in the drum of soil was expressed quantitatively and reliably. Measurements obtained in this way are to be applied in studies of water movement from soil to plants. Figures show the drum and sampling positions, root number versus root length, root void distribution and root number relation to surface area. There are 4 equations, and a table of root surface area as a position function. (Popkin-Arizona)  
W71-03501

**CALCIUM ACTIVITY, COMPLEX AND ION PAIR IN SATURATED CaCO<sub>3</sub> SOLUTIONS,**  
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.

For primary bibliographic entry see Field 02K.

W71-03502

**RADIOMETRIC METHODS OF MEASURING THE SOIL MOISTURE CONTENT,**

For primary bibliographic entry see Field 07B.

W71-03712

**EFFECTS OF PETROLEUM MULCH ON SOIL WATER CONTENT AND SOIL TEMPERATURE,**

Oregon State Univ., Corvallis. Dept. of Soils.

Ahang Kowsar.

MS Thesis, Oregon State University June 1968. 103 p, 45 fig, 6 tab, 49 ref. OWRR Project B-001-ORE (2).

Descriptors: \*Mulching, \*Soil-water-plant relationships, \*Soil temperature, \*Crop response, Evaporation control, Water conservation, Soil water movement, Soil environment, Laboratory tests.

Identifiers: \*Petroleum mulches.

Petroleum mulch applied on the soil surface over a row of planted seeds promotes a more rapid and a more uniform germination of seeds, enhance elongation of seedlings and in some cases increases the yield of the crop. An experiment was designed so that changes in soil temperature and soil water content of mulched and unmulched soil, subjected to the same radiation, could be measured under controlled conditions. Soil at a predetermined water content was packed into boxes. A band of mulch was applied to one side of the slab. The soil was subjected to a temperature cycle by turning on infrared heat lamps at 8:00 A.M., increasing the energy output until 2:00 P.M. and then decreasing the energy output until the lights were turned off at 8:00 P.M. Soil temperatures, water content, and heat flux were measured at regular intervals. The mulch-covered soil was about 5 deg C warmer than the bare soil when the soil temperatures attained maximum value. The bare soil rapidly lost water in the upper 4 cm. The mulch covered soil lost water in the upper cm of soil but gained water deeper. The beneficial effect of petroleum mulch is attributed to improved soil water conditions as well as to improved soil temperature conditions. (Knapp-USGS)  
W71-03725

**SOIL MATRIC SUCTION CHANGES WITH TIME IN PRESSED SOIL BRICKETTES,**  
Minnesota Univ., Minneapolis. Dept. of Soil Science.

Victor C. Fuentes.

MS Thesis, Minnesota University, July 1970. 68 p, 13 fig, 2 tab, 59 ref. OWRR Project B-015-MINN (3).

Descriptors: \*Soil water movement, \*Compacted soils, \*Soil moisture, \*Moisture content, Laboratory tests, Free energy, Time, Soil structure, Soil properties, Mass transfer, Crystallization, Monomolecular films, Dehydration, Soil strength, Soil physical properties, Soil physics. Identifiers: \*Soil matric suction, Clarion loam.

A Clarion loam surface soil was pulverized when dry to pass a 0.3 mm sieve. Samples were wetted to water contents ranging from 0.215 to 0.458 g/g and pressed in a brass chamber at 3.5 Kg/sq cm. At low water contents (less than 0.258 g/g) there was a rapid decrease in soil matric suction with time after pressing, indicating an increase in the free energy state of the water. At higher water contents, the rate of decrease in matric suction was smaller. At a water content of 0.258 g/g, suction remained constant with time. This indicates that at this water content the crystal internal space had a water monomolecular layer that kept the surfaces at an equilibrium distance. Therefore, there was not a mass transfer gradient present. At water contents over 0.258 g/g soil matric suction increased with time. In order to more fully understand the process of stabilization in newly-formed soil aggregates, changes in soil matric suction that come about during aging of pressed soil were measured. The aging process suggests a thixotropic reaction in which water content is known to be an important factor. (Woodard-USGS)  
W71-03728

## 2H. Lakes

**MINERALIZATION PROCESS OF ORGANIC MATTER IN LAKE WATER,**  
Nagoya Univ. (Japan). Water Research Lab.  
For primary bibliographic entry see Field 05C.  
W71-03435

**CULTURE OF LAKE HERRING IN THE LABORATORY,**  
National Water Quality Lab., Duluth, Minn.  
For primary bibliographic entry see Field 05A.  
W71-03451

**PROPERTIES OF CIRCULATION IN STRATIFIED LAKES,**  
Cornell Univ., Ithaca, N. Y. Dept. of Civil Engineering.

James A. Liggett, and Kwang K. Lee.

ASCE Proceedings, Journal of the Hydraulics Division, Vol 97, No HY1, Paper 7793, p 15-29, January 1971. 15 p, 9 fig, 14 ref.

Descriptors: \*Water circulation, \*Stratified flow, \*Lakes, Limnology, Winds, Currents (Water), Water levels, Thermal stratification, Epilimnion, Hypolimnion. Identifiers: \*Lake circulation.

An approximate method is presented to display some features of wind-driven circulation in a stratified lake. Rotation of the earth is included, but the effects of bottom topography and shoreline configuration are ignored. The free surface slopes upward in the downwind direction and upward to the right of the wind (in the northern hemisphere) whereas the thermocline has the opposite slope. The free surface slope is related to the thermocline slope by the density ratio of the stratified layers. The crosswind slope is of the order of one-fifth the downwind slope for lakes at about the latitude of the Great Lakes. These slopes decrease with increasing epilimnion thickness. Higher eddy viscosity also increases slopes, but decreases the velocities in the epilimnion. Decreased epilimnion velocities result from a smaller epilimnion thickness. (Knapp-USGS)  
W71-03671

**DIFFUSION AND ACCUMULATION OF CHLORIDE AND SODIUM IN LAKE ONTARIO, SEDIMENT,**

Department of Energy, Mines and Resources, Burlington (Ontario). Canada Center for Inland Waters.

Abraham Lerman, and Roland R. Weiler.

Earth and Planetary Science Letters, Vol 10, No 1, p 150-156, December 1970. 7 p, 4 fig, 1 tab, 17 ref.

Descriptors: \*Water chemistry, \*Bottom sediments, \*Lake Ontario, Diffusion, Ion transport, Saline water, Sodium, Chlorine, Solutes, Aqueous solutions, Water balance, Water analysis, Mud-water interfaces, Connate water, Path of pollutants. Identifiers: Lake water chemistry.

In the upper 30 cm of Lake Ontario sediment cores Na and Cl are being transferred from the lake water into the sediment. The probable cause of the transfer is the strong increase in their concentrations in the lake during the 20th century. The concentration data are compatible with diffusional transport models. Estimated values of the diffusion coefficients in the sediment-pore water column are given. The total amount of each species which has entered and accumulated in the sediment-pore water column since the concentrations in the lake began to rise is, for Cl, 2.96 mg per sq cm and for Na, 1.31 mg per sq cm. The amounts accumulated in the sediment are about 1-2% of the amounts of the two species now present in the lake water. (Knapp-USGS)

W71-03672

**PHOSPHORUS CONTENT IN UNCONSOLIDATED SEDIMENTS FROM SOUTHERN LAKE MICHIGAN,**

Illinois State Geological Survey, Urbana.

For primary bibliographic entry see Field 05A.

W71-03703

**WATER RESOURCES AND LAND USE OF THE PYRAMID LAKE INDIAN RESERVATION.**

Wilsey and Ham, San Mateo, Calif.

For primary bibliographic entry see Field 06B.

W71-03769

## II. Water in Plants

**PRELIMINARY RECONNAISSANCE OF AREAS TO BE IMPOUNDED IN THE SALT RIVER BASIN OF KENTUCKY,**

Kentucky Univ., Lexington.

Louis A. Krumholz.

Kentucky University Water Resources Institute Completion Report, February 1970. 8 p, 1 fig, 2 tab, 2 ref. OWRR Project No A-019KY (1).

Descriptors: \*Reservoir sites, \*Surveys, \*Algae, \*Biological communities, \*Kentucky, Data collections, Damsites, Investigations, On-site data collections, Ecological distribution, Ecosystems, Habitats, Plants, Animals, Population. Identifiers: Salt River basin (Ky).

A preliminary reconnaissance of areas to be impounded in the Salt River basin of Kentucky extended from 1 April through 30 June 1968. Since the first impoundment was to be at Taylorsville on the Salt River, principal effort was expended in that drainage area. A preliminary survey of vascular plants of the area to be inundated by Taylorsville Reservoir, Salt River basin, Kentucky was made to collect and catalog specimens of vascular plants, to select areas for future intensive studies of indigenous plant communities, and to select sites for long-term studies of the effects of inundation. More than 100 species of plants referable to more than 50 families were collected, identified, and catalogued. More than 50 species are indigenous to the area. The area is productive of animals. The invertebrate and vertebrate faunas are abundant and diverse. Preliminary stations for the collections of aquatic organisms, water samples, and other data

germane to the study were established. (Knapp-USGS)

W71-03315

**PHOTOSYNTHETIC SYSTEMS OF MEDITERRANEAN-CLIMATE SHRUBS AND TREES OF CALIFORNIA AND CHILE,**

Stanford Univ., Calif. Dept. of Biological Sciences.

H. A. Mooney, and E. L. Dunn.

NSF (GB 8184) (GB 5223). American Naturalist, Vol 104, No 939, p 447-453, September-October 1970. 5 fig, 1 tab, 6 ref.

Descriptors: \*Photosynthesis, \*Leaves, \*Root systems, \*Habitats, \*Water balance, Semiarid climates, Biological communities, Ecosystems, Shrubs, Trees, Xerophytes, Cacti, California, Chaparral, Carbon dioxide, Ecological distribution, Drought tolerance, Drought resistance, Altitude, Environmental effects, Mode of action, Energy budget, Energy conversion, Efficiencies, Light, Temperature, Soil moisture, Gradation, Soil-plant relationships, Deciduous trees, Coniferous trees, Wet seasons, Dry seasons.

Identifiers: \*Evergreens, \*Sclerophyllous plants, \*Succulents, \*Chile, Assimilation, Mediterranean climate.

Mediterranean-type climatic areas of both California and Chile lie in the same latitudinal zones. Dominant growth forms of the plant communities occur at about the same position along a moisture gradient extending over 80-1600 mm annual precipitation. From wet to dry end of the gradient occur evergreen trees, evergreen shrubs, drought-deciduous shrubs and succulents. Plant cover, stature and evergreen leaf size decrease with increasing aridity. Since these communities from each hemisphere had different evolutionary histories, convergent evolution suggests limited adaptive options along these climatic gradients. The drought-deciduous plants have photosynthetic rates twice as great as the evergreen species. Further, they are characterized by shallow root systems which more efficiently utilize temporally limited soil moisture and lower foliage densities which eliminate competition for light and facilitate carbon dioxide uptake. When water supplies vanish, the leaves are shed. The low energy costs in leaf production combined with high assimilation capacity result in much more energy available for growth and storage per unit time in contrast with the evergreen species and their small, densely packed, yearround leaves with deep roots utilizing deep soil water. (Casey-Arizona)

W71-03329

**THE ROLE OF THE MESOPHYLL CELL WALL IN LEAF TRANSPERSION,**

Australian National Univ., Canberra. Research School of Biological Sciences.

P. G. Jarvis, and R. O. Slatyer.

Planta (Berlin), Vol 90, No 3, p 303-322, 1970. 7 fig, 28 ref.

Descriptors: \*Water balance, \*Leaves, \*Stomata, \*Vapor pressure, \*Water transfer, Nitrogen compounds, Plant physiology, Saturation, Evaporation, Flow control, Resistance, Moisture stress, Carbon dioxide, Transpiration, Evapotranspiration control, Mode of action, Physiological ecology, Cytological studies, Cuticle, Pores, Diffusion, Hydraulic conductivity, Equations, Moisture content, Cotton, Water vapor. Identifiers: \*Water potential, \*Leaf mesophyll, \*Leaf flow resistances.

Two main pathways are generally recognized in plant transpiration: movement through cuticles and movement through stomatal pores. Stomatal resistance has generally been considered the limiting factor in transpiration of water-stressed plants but other mechanisms, particularly lengthening of mesophyll cell diffusion pathways, have been considered. The value of the cell wall resistance ( $r_{sub w}$ ) was determined by calculating and comparing leaf resistances to water vapor diffusion and to

nitrous oxide vapor diffusion. The latter will not contain  $r_{sub w}$ . The 2 outstanding results were that  $r_{sub w}$  values were greater than 2.0 sec/cm and that they increased with increasing transpiration rates and water stress. In the calculations, the same result would be obtained with increasing  $r_{sub w}$  or decreasing water vapor concentration at the cell evaporating surface ( $c_{sub w}$ ). A number of possible mechanisms were considered and it is felt that the most likely is the existence of a zone of low hydraulic conductivity associated with the cutinized outer cell wall layer which leads to decreasing  $c_{sub w}$ . It is conceded that the long-standing assumption of uniform saturation vapor pressures at cell wall evaporating sites, may not be true. (Casey-Arizona)

W71-03330

**A CRITICAL EVALUATION OF TISSUE-IMMERSION METHODS FOR MEASUREMENT OF PLANT WATER POTENTIAL,**

Arizona Univ., Tucson. Environmental Research Lab.

James W. O'Leary.

Ohio Journal of Science, Vol 70, No 1, p 34-38, January 1970. 1 fig, 30 ref.

Descriptors: \*Osmotic pressure, \*Free energy, \*Laboratory tests, \*Plant tissues, \*Plant physiology, Analytical techniques, Water analysis, Thermodynamic behavior, Physicochemical properties, Equilibrium, Movement, Flow, Moisture uptake, Mode of action, Absorption, Water measurement, Flow measurement, Moisture stress, Measurement, On-site investigations, Infiltration.

Identifiers: \*Water potential, \*Plant-water relationships, \*Tissue-immersion methods.

Water moves into, through and out of plants along free-energy gradients expressed by the term water potential (psi). Since water potential reflects plant water stress, its measurement in the field is desirable. For practical reasons, only methods involving immersion of tissue segments in graded osmotic solutions are possible. Theoretically, equal values should be obtained by measurements of tissue change (length, weight, or volume) and by measurements of solute concentration changes. Cylinders of potato tissue were immersed in sucrose solutions of 1-12 bars osmotic pressure and water potentials were measured by the Schardakow-dye method and the change-in-length method. In 8 of 14 measurements the change-in-length underestimated psi. Errors inherent in the method are discussed. Probably the most crucial error factor is infiltration into intercellular spaces leading to tissue stretching. It is concluded that only the dye method is suitable for field measurements. (Casey-Arizona)

W71-03331

**THE BEHAVIOR OF LARREA DIVERICATA (CREOSOTE BUSH) IN RESPONSE TO RAINFALL IN CALIFORNIA,**

Oxford Univ. (England). School of Botany.

S. R. J. Woodell, H. A. Mooney, and A. J. Hill.

Journal of Ecology, Vol 57, No 1, p 37-44, March 1969. 2 fig, 3 tab, 15 ref.

Descriptors: \*Vegetation, \*Xerophytes, \*Sampling, \*Ecology, \*On-site investigations, Arid lands, Environmental effects, On-site data collections, Estimating, Measurements, Probability, Reliability, Statistical methods, Variability, Rainfall, Shrubs, Deserts, Mode of action, Competition, Root systems, Biological communities, California, Density, Crop response, Distribution patterns, Correlation analysis, Spatial distribution.

Identifiers: \*Creosote bush.

Creosote bush locations in 8 differing desert areas were sampled and analyzed for spacing regularity. The spatial distribution were then correlated with rainfall. The sampling methods used were either the variance/mean ratio or Pielou's point-to-plant distance method, which uses density estimates and a selection of random points. The results showed a

## Field 02—WATER CYCLE

### Group 21—Water in Plants

fairly good correlation of density with annual rainfall. *Larrea* density seemed independent of other shrubs, although all followed the same general trends. The density of other shrubs was high on coarser soils with moderate rainfall and low on either sandier soils or lower rainfall. Regular distribution in sparse *Larrea* stands is very likely a result of root competition for available water. The theory of spacing by toxic root secretions was considered and deemed unlikely. (Casey-Arizona)  
W71-03334

#### ECO-PHYSIOLOGICAL STUDIES ON PLANTS IN ARID AND SEMI-ARID REGIONS IN WESTERN AUSTRALIA. II: FIELD PHYSIOLOGY OF ACACIA CRASPEDOCARPA F. MUELL.,

Western Australia Univ., Nedlands. Dept. of Botany.

Erhart O. Hellmuth.

Journal of Ecology, Vol 57, No 3, p 613-634, November 1969. 10 fig, 6 tab, 29 ref.

Descriptors: \*Physiological ecology, \*Photosynthesis, \*Transpiration, \*Water balance,

\*Xerophytes, Arid lands, Legumes, Water conservation, Solar radiation, Temperature, Osmosis, Desert plants, On-site investigations, Metabolism, Environmental effects, Mode of action, Photoactivation, Cuticle, Drought resistance, Heat resistance, Light, Carbon dioxide, Microenvironment, Stomata, Turgidity, Economic efficiency, Moisture deficit, Semiarid climates, Diurnal, Seasonal.

Identifiers: \*Australia, \*Acacias, \*Phyllodes, \*Transpiration ratio, \*Water potential, Sclerophylloous plants, Photosynthetic efficiency.

*Acacia craspedocarpa* is a phyllodinous sclerophyll type xerophyte of Western Australia. As the dry season progresses, the phyllodes turn from green to yellowish and their cuticles thicken and develop and 'epistomal cavity' which reduces to a narrow pore - 3-5 microns wide. Essentially this structure increases resistance to water movement without affecting carbon dioxide assimilation so that photosynthetic efficiency increases throughout the summer. Stomatal closure does not occur even though transpiration decreases with increasing water deficit. This is correlated with a number of other xeric adaptations. Saturation light intensities for photosynthesis were fairly low (about 850-1000 ft.-candles). Once saturation intensities were achieved, both photosynthetic and respiration rates were controlled by phyllode temperatures, which were never greater than 6 degrees C. above air temperature. Therefore, they never reached the point of heat damage. Water deficits reach 33 percent before zero turgor is reached; possibly hydrophilic colloids with imbibitional forces are involved. (Casey-Arizona)  
W71-03335

#### VEGETATION OF THE ERER-GOTA PLAIN, ETHIOPIA,

Haiile Selassie I Univ., Addis Ababa (Ethiopia).

Edward W. Beals.

NSF GB-1694. Journal of Ecology, Vol 57, No 3, p 655-667, November 1969. 4 fig, 3 tab, 24 ref.

Descriptors: \*Distribution patterns, \*Vegetation, \*Biological communities, \*Semiarid climates, \*Ecological distribution, Shrubs, Trees, Grasses, Data collections, On-site investigations, Ecosystems, Sampling, Data processing, Statistics, Legumes, Plant groupings, Plant populations, Hardpan, Soil moisture, Salinity, Mapping, Environmental effects, Rainfall, Altitude, Nitrogen, Correlation analysis, Frequency analysis, Grasslands.

Identifiers: \*Stand arrangement, \*Plant associations, \*Africa, \*Ethiopia, Base exchange capacity, Ordination.

Species and vegetation-type distributional patterns of 6 semidesert plant communities were analyzed by ordination techniques. The study area was the

southern Afar Depression of Ethiopia where rainfall estimates are 25-50 cm/year. Data analysis was based largely on Cole's index of association and each species was placed in a 2-dimensional ordination. Coordinates of the ordination were used as adaptation numbers to place each of the 18 stands of vegetation in a 2-dimensional continuum. The following vegetation types were discerned: open grassland, *Acacia arabica* scrub, *A. ehrenbergiana* scrub, *Cadaba rotundifolia* scrub, *Tamarix orientalis* woodland and *A. nubica* scrub. In all stands perennial grasses were the dominant cover. The stand ordination maps showed a clearcut separation between the first 3 and the last 3 vegetation types. The break probably results from presence of a hardpan below soil surface in the former stands. The same stands were also much richer in salts. Ecological factors underlying the various distributions are discussed and ordination techniques seem valid. Correlations appear probably between stand arrangement and water level, particularly in view of rainfall and soil moisture retention. Definite correlations were found between stand arrangement and altitude, soil base exchange capacity, and soil N. (Casey-Arizona)  
W71-03336

#### ESTIMATION OF WATER STRESSES IN THE ACTIVE ROOT ZONE OF SOME NATIVE HALOPHYTES IN ISRAEL,

Tel Aviv Univ., (Israel). Dept. of Botany.

Y. Waisel, and G. Pollak.

Journal of Ecology, Vol 57, No 3, p 789-794, November 1969. 2 fig, 2 tab, 9 ref.

Descriptors: \*Soil-water-plant relationships, \*Halophytes, \*Arid lands, \*Moisture stress, \*Root systems, Physiological ecology, Habitats, On-site investigations, Shrubs, Xerophytes, Biological communities, Laboratory tests, Wilting point, Soil horizons, Soil texture, Niches, Environmental effects, Balance of nature, Water balance, Drought tolerance, Drought resistance, Moisture content, Fluctuation, Monthly, Equilibrium, Plant growth. Identifiers: \*Water potential, \*Israel.

Since plant habitats are highly variable, both topographically and in soil layers, root moisture stress determinations by soil sampling are almost impossible. Glass sleeves were installed on branches of naturally growing large halophytic plant species in a saline area near the Dead Sea. Between 6-12 weeks later adventitious root systems developed inside the sleeves and their water potentials equilibrated with the water potentials of the sleeve soils. The adventitious root and ground root water potentials were linearly correlated. Mean water potentials obtained for various months of the year ranged for -0.340-50 bars, depending on the species and ecological niche. The lower stress levels were far beyond the 1-15 bar wilting point usually found in the lab. Depending upon magnitude of annual stress fluctuations and year-round growth, the plants were classified as: (1) poikilohydric drought avoiding - *Aeluropus litoralis*, (2) poikilohydric drought enduring - *Arthrocnemum glaucum* and *Tamarix jordanis* and (3) stenohydric drought enduring - *Suaeda monoica* and *Nitraria retusa*. Despite occurring together in the same habitat, *Tamarix* and *Suaeda* roots exploited different soil horizons. (Casey-Arizona)

W71-03337

#### SOLAR RADIATION AND THE USE OF IT BY PLANTS,

Main Geophysical Observatory, Leningrad (USSR).

M. I. Budyko.

Agroclimatological Methods; Proceedings of the Reading Symposium, Natural Resources Research, Vol 7, p 39-53, UNESCO, 1968. 16 fig, 18 ref.

Descriptors: \*Distribution patterns, \*Solar radiation, \*Photosynthesis, \*Climatology, \*Data collections, Carbon dioxide, Productivity, Temperature, Estimating equations, Environmental effects, Turbulence, Evaporation, Theoretical analysis, Radiation

Infrared radiation, Respiration, Vegetation, Light, Energy transfer, Measurement, Mode of action, Heat balance, Plant growth, Meteorological data, Maps, Networks, Stations, Synoptic analysis. Identifiers: \*Agroclimatology, \*Actinometric stations, \*USSR, \*Radiation balance, \*Assimilation.

The world actinometric network numbers over 1000 stations and supplies observational data for the determination of normal values of the radiation regime for much of the Earth's surface. Computational methods have been devised for calculation of the components of the radiation regime from basic meteorological data, and calculated values of radiation balance agree within a few percent with measurements. World maps of total yearly radiation, January and July radiation and radiation balance are presented. World maps of heat balance components and evaporation are also available. While year to year values of total radiation and radiation balance are relatively stable, the variability of shorter time intervals increases considerably. A theory of photosynthesis in vegetation is developed which takes into account radiation penetration and carbon dioxide diffusion. It appears that under conditions of sufficient soil moisture, vegetation cover productivity is most strongly dependent upon 2 factors—photosynthetically active radiation and temperature. The accumulation of radiation data and studies of empirical relationships between plant productivity and radiation and other climatic factors has made it possible to compile maps of plant productivity and utilization of solar radiation for various geographical regions. (Casey-Arizona)  
W71-03344

#### INTERROW WATERSHEDS,

Texas Agricultural Experiment Station, College Station.

For primary bibliographic entry see Field 03F.  
W71-03486

#### CORN IRRIGATION FIELD STUDY IN MULESHOE AREA, 1969,

Texas Agricultural Experiment Station, College Station.

For primary bibliographic entry see Field 03F.  
W71-03490

#### AN IRRIGATION TREATMENT-YIELD STUDY WITH CORN GROWN ON THE TEXAS HIGH PLAINS,

Texas Agricultural Experiment Station, College Station.

For primary bibliographic entry see Field 03F.  
W71-03492

#### CORN DATE-OF-PLANTING AND IRRIGATION TIMING STUDY,

Texas Agricultural Experiment Station, College Station.

For primary bibliographic entry see Field 03F.  
W71-03493

#### CESIUM UPTAKE BY SUDANGRASS SEEDLINGS FROM FOUR SOILS IN SOUTHERN CALIFORNIA,

California Univ., Riverside. Dept. of Soils and Plant Nutrition.

Malek T. Kaddah.

AEC contract AT 11-1-34 P 92. Soil Science, Vol 105, No 5, May 1968, p 369-375. 4 tab, 15 ref.

Descriptors: \*Soil-water-plant relationships, \*Cesium, \*Sudangrass, \*Absorption, \*California, Saline water, Ammonium salts, Potassium compounds, Arid lands, Toxicity, Loam, Soil chemistry, Crop response, Salts, Ions, Ammonium compounds. Identifiers: \*Neubauer technique, \*Seedlings, \*Cesium chloride.

Cesium uptake by four arid soils in micro and macroamounts with salts was studied by a modified

## Erosion and Sedimentation—Group 2J

Neubauer technique using sudangrass as a testing plant. Little differences were exhibited when Cs additions ranged from 10 to the minus 7 to 10 to the minus 2 meq/100g soil. Cs toxicity symptoms commenced when Cs concentration in the shoots were 0.02 to 0.03 meq/Cs/g dry shoots. When Cs was added to soils in microamounts (less than 10 to the minus 4 meq/100g) with different salts, Cs availability was influenced by the salt concentration, especially of K and NH<sub>4</sub> sub 4 salts. When 0.1 meq CsCl was added to 100 g soil, the NH<sub>4</sub> sub 4 enhancing effect on Cs absorption did not occur. Cs under macroconcentration affect K and NH<sub>4</sub> sub 4 availability. For any concentration of Cs added, the Cs uptake was higher when it was added after rather than before NH<sub>4</sub> sub 4 or K ions, especially in vermiculitic soils and with increasing Cs concentration. Tables of salt, soil KCl and NH<sub>4</sub> Cl, and CsCl effects on Cs uptake by sudangrass seedlings are included. (Popkin-Arizona)  
W71-03496

**A SOIL AND VEGETATION PATTERN IN THE SANTA CATALINA MOUNTAINS, ARIZONA,**  
California Univ., Irvine; and North Carolina State Univ., Raleigh.  
For primary bibliographic entry see Field 02G.  
W71-03498

**QUANTITATIVE STUDIES OF ROOTS IN SOIL. I. LENGTH AND DIAMETERS OF COTTON ROOTS IN A CLAY-LOAM SOIL BY ANALYSIS OF SURFACE-GROUND BLOCKS OF RESIN-IMPREGNATED SOIL,**  
Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Irrigation Research Lab.  
For primary bibliographic entry see Field 02G.  
W71-03501

**THE POTENTIAL USE OF TREE RINGS IN HYDROLOGIC INVESTIGATIONS IN EASTERN NORTH AMERICA WITH SOME BOTANICAL CONSIDERATIONS,**  
Geological Survey, Arlington, Va.  
Richard L. Phipps.  
Water Resources Research, Vol 6, No 6, p 1634-1640, December 1970. 7 p, 3 fig, 6 ref.

Descriptors: \*Soil-water-plant relationships, \*Dendrochronology, Dating, Climatology, Ecology, Forests, Lumbering, Growth rates, Paleoclimatology, Plant growth, Trees.  
Identifiers: \*Tree-ring hydrology.

Trees add a new growth layer, or ring, each year. Because growth is controlled in part by environment, analysis of tree rings can potentially yield information concerning past hydrologic (or other environmental) conditions. The present state of understanding of the relationship between tree growth and the hydrologic environment in the eastern United States does not allow detailed estimates of past environments from tree rings. It does appear though, that within the near future it will be possible to estimate certain hydrologic parameters in space (between gaging stations) from tree growth phenomena. For the present, however, examination of tree rings is most useful in hydrologic studies for dating of events. (Knapp-USGS)  
W71-03679

## 2J. Erosion and Sedimentation

**THE EFFECT OF RAINDROP IMPACT AND SURFACE ROUGHNESS ON SHEET FLOW,**  
Illinois Univ., Urbana. Water Resources Center.  
For primary bibliographic entry see Field 02B.  
W71-03310

**INSIGHTS GAINED FROM RIVER SEDIMENTATION MODELS,**  
Army Engineer Waterways Experiment Station, Vicksburg, Miss.

J. J. Franco.

Prepared for presentation at the Hydrologic Engineering Seminar on Sediment Transport in Rivers and Reservoirs, held at Hydrologic Engineering Center, Davis, Calif., April 1970. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper H-70-2, April 1970. 16 p, 6 ref.

Descriptors: \*Sedimentation, \*Sediments, \*Sediment transport, Hydraulic models, Alluvial channels, Rivers.

Movement of sediment in alluvial streams presents many problems that must be considered in the development and improvement of these streams for navigation and flood control. Laboratory investigations have contributed to a better understanding of sedimentation processes, but very little information is available on control of sediment movement in natural streams. The Waterways Experiment Station has conducted a number of studies concerned with the solution of specific problems in unusually troublesome or unstable reaches. Some of these studies and results, summarized in this report, are: Arkansas River development for navigation; movement of sediment between locks and dams; shoaling in lower lock approach; dike systems; bifurcated channels; and open river problems. (Spivey-WES)  
W71-03325

**GEOMETRIC STABILITY ANALYSIS OF AN ALLUVIAL RIVER,**  
Corps of Engineers, Vicksburg, Miss. Potamology Section.  
For primary bibliographic entry see Field 08B.  
W71-03383

**CONTROL OF SCOUR AT HYDRAULIC STRUCTURES,**  
Army Engineer Waterways Experiment Station, Vicksburg, Miss. Hydraulics Div.  
For primary bibliographic entry see Field 08B.  
W71-03384

**THE USE OF FALLOUT CESIUM-137 AS A TRACER OF SEDIMENT MOVEMENT AND DEPOSITION,**  
Agricultural Research Service, Oxford, Miss., Sedimentation Lab.  
For primary bibliographic entry see Field 07B.  
W71-03385

**STRATIGRAPHY, SEDIMENTOLOGY, AND MOISTURE CONTENTS IN A SMALL LOESS WATERSHED IN TAMA COUNTY, IOWA,**  
Iowa State Univ., Ames. Dept. of Agronomy.  
For primary bibliographic entry see Field 02G.  
W71-03440

**EROSION CONTROL ON AIR FORCE BASES,**  
Water Resources Engineers, Inc., Walnut Creek, Calif.

DeLynn R. Ray, D. F. Kibler, and C. E. Busby.  
Available from NTIS as AD-713 644, \$3.00 in paper copy, \$0.95 in microfiche. Technical note, WLC-TN-70-018, Aug 1970. 25 p, 14 ref. Air Force Contract F29601-69-C-0039.

Identifiers: \*Erosion, Control, \*Sails, Erosion, \*Construction, Military facilities, State-of-the-art reviews, Rainfall, Drainage, Intensity, Exposure, Terrain, Wind, Water, Particles, Air Force Operations.

A state-of-the-art review of the soil erosion field as it relates to the erosion control needs of the US Air Force was conducted. The review will serve as a guide for preparation of a Base Civil Engineer erosion control handbook. Typical military construction activities which have exposed large areas of unprotected soil and subsequently have led to serious erosion problems are presented. Factors involved in the wind and erosion processes are discussed and soil-loss equations and soil erodibility

indices are reviewed. The erodibility K-factor in the ARS soil-loss equation is evaluated for land management planning techniques. Guidelines for effective erosion control practices to protect exposed land surfaces against soil particle detachment and transport by either water or wind are presented. Further efforts to establish a more reliable erodibility index which can be used to define areas of highly erodible soils, especially for subsurface soils that are exposed during construction are indicated.  
W71-03530

### PROBLEMS IN ACHIEVING SOIL AND WATER CONSERVATION.

National Academy of Sciences, Washington, D.C.  
For primary bibliographic entry see Field 05G.  
W71-03634

### SEDIMENT TRANSPORTATION MECHANICS: F. HYDRAULIC RELATIONS FOR ALLUVIAL STREAMS.

ASCE Proceedings, Journal of the Hydraulics Division, Vol 97, No HY1, Paper 7786, p 101-141, January 1971. 41 p, 10 fig, 2 tab, 64 ref, append.

Descriptors: \*Alluvial channels, \*Sediment transport, \*Bed load, \*Sedimentary structures, \*Channel morphology, Sedimentation, Streamflow, Fluid friction, Roughness (Hydraulic), Stage-discharge relations, Discharge (Water), Discharge measurement, Velocity.  
Identifiers: \*Bed forms (Alluvial channels).

The several bed forms found in alluvial streams are described and the theoretical treatment of these forms is outlined briefly. The general problem of flow in alluvial streams is then analyzed in general terms and the variables governing such flows and the seven relationships between them are identified. Among these relationships are the friction factor relation and the sediment discharge relation which are of primary importance to engineers. This analysis serves as an introduction to the main part which deals with prediction of the stage-discharge relation. In this part several of the most important methods of calculating these relations are presented clearly and concisely. The paper will be of interest to many engineers and engineering students not only because it presents practical methods for calculating the relation between discharge, velocity and depth of alluvial streams but also because of the fundamental concepts outlined in it. (See also W71-03668) (Knapp-USGS)  
W71-03667

### SEDIMENT TRANSPORTATION MECHANICS: Q. GENETIC CLASSIFICATION OF VALLEY SEDIMENT DEPOSITS.

ASCE Proceedings, Journal of the Hydraulics Division, Vol 97, No HY1, Paper 7815, p 43-53, January 1971. 11 p, 1 fig, 1 tab, 37 ref.

Descriptors: \*Sediment transport, \*Sedimentary structures, \*Classification, \*Sediments, \*Alluvium, Bed load, Rivers, Alluvial channels, Geology, Sedimentation, Sedimentology, Silts, Gravels, Sands, Sand bars, Deltas.  
Identifiers: \*Alluvium classification.

Valley fluvial sediment deposits are classified according to origin. All such deposits are intergradational, but most can be classified as dominantly transitory channel deposits, lag deposits, lateral or vertical flood plain accretions, splays, channel fill, or colluvium. Mass movements, especially mudflows but also debris avalanches and earthflows in places, form significant deposits under limited circumstances. Other terms are useful for typical surface forms, subdivisions or associations of types of deposits. Point bars are the most conspicuous forms of lateral accretion. Vertical accretion includes natural levee, backland and backswamp

## Field 02—WATER CYCLE

### Group 2J—Erosion and Sedimentation

deposits, although splays are also important in natural levees. Channel fills range from coarse-grained to fine clay plugs. Alluvial fans and deltas are associations of types of deposits, characteristic of specific topographic situations. Valley plugs are fan-like local concentrations along filled channels, with characteristic splays, but not in typical alluvial fan locations. (See also W71-03667) (Knapp-USGS)  
W71-03668

**TOPOLOGICAL AND GEOMETRICAL PROPERTIES OF BRAIDED STREAMS,**  
Virginia Univ., Charlottesville.  
Alan D. Howard, Mary E. Keetch, and C. Linwood Vincent.  
Water Resources Research, Vol 6, No 6, p 1674-1688, December 1970. 15 p, 6 fig, 3 tab, 27 ref.

Descriptors: \*Braiding, \*Alluvial channels, \*Sediment transport, \*Mathematical models, Regime, Channel morphology, Networks, Sediment load, Bed load, Deposition (Sediments), Distribution patterns.

Identifiers: \*Topology (Channels).

Strong relationships among dimensionless properties of braided streams indicate that similarity is preserved in streams with the same average number of channels but of different sizes. The degree of braiding in streams, conveniently measured by the average number of channels bisected by lines crossing the channel, increases with the product of discharge and gradient, but decreases with higher variance in discharge. A random walk simulation model of braiding duplicates many of the numerical relationships observed in natural streams, suggesting that most of the downstream variation in the number of channels in braided streams is explainable by local fluctuations in discharge and sediment in transport, as opposed to large-scale factors such as valley constriction. (Knapp-USGS)  
W71-03683

**VEGETATION AND WATERSHED SHAPE,**  
Cornell Aeronautical Lab., Buffalo, N.Y.  
Thomas R. Magorian.  
Water Resources Research, Vol 6, No 6, p 1759-1764, December 1970. 6 p, 4 fig, 6 ref.

Descriptors: \*Geomorphology, \*Watersheds (Basins), \*Vegetation effects, \*Statistical models, Channel morphology, Distribution patterns, Topography, Small watersheds, Erosion, Hydraulic models, Simulated rainfall.

Identifiers: \*Random walk method, \*Stream order, First order drainage basins.

The length L of vegetated first order watersheds developed by fluvial erosion is related to the width W by  $L = W \sqrt{RU}$ , where R is 3 for converging random walks of step size U, whose observed mean is 3 meters for normal dendritic drainage and 40 meters for basins over 300 meters long that drain directly into third or higher order streams. Bare soil watersheds show the relation  $L = 0.4 W$ . (Knapp-USGS)  
W71-03692

**POSSIBLE EFFECTS OF PRECIPITATION MODIFICATION ON STREAM CHANNEL GEOMETRY AND SEDIMENT YIELD,**  
Pennsylvania State Univ., University Park.  
For primary bibliographic entry see Field 03B.  
W71-03693

**NOTES ON BEACH EROSION IN THE CHARLESTON HARBOR AREA,**  
Citadel, Charleston, S.C. Dept. of Chemistry.  
For primary bibliographic entry see Field 02L.  
W71-03701

**QUALITY OF SURFACE WATERS OF THE UNITED STATES, 1965: PARTS 5 AND 6. HU-**

**SON BAY AND UPPER MISSISSIPPI RIVER BASINS, AND MISSOURI RIVER BASIN.**  
Geological Survey, Washington, D.C.  
For primary bibliographic entry see Field 07C.  
W71-03707

prominent bar and those without a bar. Migration of these sand waves may well produce pulsational transfer of material along the shore. (Knapp-USGS)  
W71-03715

**SIMULATION OF HORIZONTAL TURBULENT DIFFUSION OF PARTICLES UNDER WAVES,**  
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.

Stephen P. Murray.

Available from NTIS as AD-700 560, \$3.00 in paper copy, \$0.95 in microfiche. Louisiana State University Coastal Studies Institute Technical Report No 72, p 446-466, October 1969. 21 p, 11 fig, 4 tab, 19 ref. (Reprinted from Proceedings of 11th Conference on Coastal Engineering, September 1968, London, England, published by American Society of Civil Engineers, 1969.) Contract Nonr 1575 (03) NR 388 002 ORN.

Descriptors: \*Waves (Water), \*Turbulent flow, \*Diffusion, \*Sediment transport, \*Hydraulic models, Turbulence, Diffusivity, Model studies, Beaches, Settling velocity, Suspension.

Identifiers: \*Turbulent diffusion.

By oscillation of an array of turbulence-generating grids in still water, the turbulent fluid velocity field in shoaling waves near the bottom was simulated in a laboratory channel. Solid particles with fall velocities varying between 1 and 40 mm/sec were introduced into the test volume from above. Multiple-image photography recorded the grain trajectories. The Lagrangian intensities of turbulence and diffusion coefficients were directly measured from the photographic data. The scale times, scale lengths, and the frequencies of the power spectra modes can then be calculated. The turbulent velocity distributions of both fluid and heavy particles are Gaussian, and their standard deviations increase regularly with increasing grid Reynolds numbers. Diffusion coefficients also increase with increasing grid Reynolds numbers. Diffusivities of the heavy particles are a function of both particle fall velocity and the structure of the fluid turbulence. (Knapp-USGS)  
W71-03714

**COLLECTIVE MOVEMENT OF SEDIMENT IN LITTORAL ENVIRONMENT,**  
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.

Choule J. Sonu.

Available from NTIS as AD-700 560, \$3.00 in paper copy, \$0.95 in microfiche. Louisiana State University Coastal Studies Institute Technical Report No 71, p 373-400, October 1969. 28 p, 16 fig, 35 ref. (Reprinted from Proceedings of 11th Conference on Coastal Engineering, September 1968, London, England, published by American Society of Civil Engineers, 1969.) Contract Nonr 1575 (03) NR 388 002 ORN.

Descriptors: \*Sand waves, \*Sediment transport, \*Beaches, Waves (Water), Littoral drift, Currents (Water), Bed load, Sands, Surf, Ocean waves, Sedimentation, Topography, Sand bars, Sedimentary structures.

Identifiers: \*Sand waves (Beaches).

Collective movements of sediment occur in the form of sand waves in the nearshore zone and affect beach topography to a significant extent. Bar-type sand waves move only in the onshore direction and account for various accretive profiles on the subaerial beach. When the beach is eroded, these sand waves are simply disintegrated on the subaerial beach, instead of migrating back in the form of sand waves. These characteristics of bar-type sand waves help explain dynamic behavior of beach profiles with respect to profile configuration, sediment storage, and beach width. Cusp-type sand waves are considered to be a product of interaction between longshore currents and an erodible bed. Their presence causes variability in beach profiles along the shore between those containing a

**BRIDGE DESIGN CONSIDERING SCOUR AND RISK,**

Arizona Univ., Tucson; and Bureau of Public Roads, Washington, D.C.  
For primary bibliographic entry see Field 08A.  
W71-03739

**THE 1966 GUERNSEY RESERVOIR SEDIMENT SURVEY,**

Bureau of Reclamation, Denver, Colo. Office of Chief Engineer.

Joe M. Lara.

Available from NTIS as PB-195 013, \$3.00 in paper copy, \$0.95 in microfiche. Bureau of Reclamation Report REC-OCE-70-22, July 1970. 56 p, 29 fig, 8 tab, 9 ref.

Descriptors: Sediment distribution, \*Reservoir silt-ing, Sedimentation, \*Reservoir surveys, Range lines, Wyoming, Deltas, Contours, Degradation, Sediment production, Fluvial hydraulics, Sediment transport, Gamma rays, Sonar, \*Sediment sampling, Field investigations, Unit weight, Watersheds (Basins), Radioactivity.

Identifiers: \*Reservoir capacity, Gamma probes, Guernsey Reservoir (Wyo), Sediment deposits.

The 1966 sediment survey of Guernsey Reservoir was made to determine the present reservoir capacity and the quantity of sediment accumulated since the dam was closed in 1927. Present capacity of the reservoir is 45,228 acre-ft and the surface area is 2,377 acres at normal water surface elevation 4420 ft. The total volume of sediments accumulated in the reservoir amounted to 28,582 acre-ft below elevation 4420 ft. Sediments accumulated at an annual rate of 719 acre-ft between 1927 and 1966. Twenty-one sediment samples of reservoir deposits were collected and a gamma probe was used to measure wet bulk densities of these deposits at 20 reservoir ranges. Analyses of samples collected in 1947, 1957, and 1966 showed an average unit weight of 54 lb/cu ft. Size analyses of samples collected during the 3 surveys resulted in an average breakdown of 43% clay, 44% silt, and 13% sand. A sonic depth recorder was used to make the hydrographic survey. The reservoir capacity was computed on the basis of areas determined by a width ratio method.  
W71-03768

## 2K. Chemical Processes

**ANALYSIS OF SOLUTIONS FOR SURFACE ACTIVE AGENTS,**  
Kentucky Water Resources Inst., Lexington. Kentucky Univ., Lexington. Dept. of Chemistry.  
Henry H. Bauer.

Available from NTIS as PB-196 660, \$3.00 in paper copy, \$0.95 in microfiche. Kentucky Water Resources Institute Project Completion Report, Research Report No 39, 1970. 17 p, 4 tab, 22 ref. OWRR Project A-014-KY (1).

Descriptors: \*Analytical techniques, Pollutant identification, \*Electrochemistry, Aqueous solutions, Electrolysis, \*Salts.

Identifiers: \*Tensammetry, \*Surface active agents.

The objective was to obtain a better understanding of the behavior of surfactants in aqueous solutions at electrodes. With this understanding it should be possible to design electrochemical methods for the detection, identification, and quantitative determination of such substances. This study was concerned primarily with the influence of extraneous salts on the behavior of surface active agents when these are examined by the electrochemical technique known as tensammetry. The tensammet-

ric method consists essentially of the measurement of the electrical impedance of an electrochemical cell. This impedance is characteristically increased in the presence of surfactants at those potentials where the surfactants are adsorbed on the electrode. At sufficiently negative and at sufficiently positive polarization, surfactants are adsorbed, and at these absorption potentials, the impedance of the cell is decreased. Curves of admittance as a function of polarization of the electrode therefore usually show two tensammetric waves. The extent of surface activity is proportional to the separation between the two tensammetric waves, to the heights of these waves, and to the degree to which the impedance is increased at polarizations between the two waves. Since tensammetric measurements can be made only in solutions of sufficiently high conductivity, the nature and effects of added salts on the result obtained is a considerable importance. In this study it was found that the salt effect is relatively unimportant when the salt concentration is not greater than approximately 0.1 m. This concentration might then be used as a standard condition for making measurements of the surfactant concentration in aqueous solution. The applicability of the technique to the analysis of surface active agents under actual field conditions was not attempted.

W71-03305

**DEVICE FOR FIELD DETERMINATION OF HEAVY METALS IN NATURAL WATERS,**  
Illinois Univ., Urbana. Water Resources Center.  
For primary bibliographic entry see Field 05A.  
W71-03311

**INTERFERENCE STUDIES IN THE DETERMINATION OF SODIUM, POTASSIUM, CALCIUM, AND MAGNESIUM IN NATURAL WATERS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY,**  
Agricultural Research Service, Oxford, Miss., Sedimentation Lab.

L. L. McDowell, and M. E. Ryan.

In Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ Water Resources Research Institute, p 163-180, 1970. 18 p, 8 fig, 2 tab, 25 ref. OWRR Project A-999-MISS (6).

Descriptors: \*Analytical techniques, \*Water analysis, \*Spectrophotometry, Chemical analysis, Flame photometry, Ionization, Chemical reactions, Sodium, Potassium, Calcium, Magnesium.

Identifiers: \*Atomic absorption spectrophotometry, \*Spectrophotometry (Atomic absorption).

In atomic absorption spectrophotometry, significant ionization errors were encountered using the air-acetylene flame in determining Na, K, and Ca in natural waters. The alkali metals, Na and K, enhance the absorption of each other because of their low ionization potentials. Ca and Mg were ionized slightly in an oxidizing flame, causing an error in the determination of Na and K. The absorption of Mg was not affected significantly by the presence of 500 ppm Na, K, or Ca. As little as 200 ppm Cs reduced the ionization errors caused by Na, K, Ca, and Mg to an acceptable level (2%) for routine analyses. An ionization suppressant should always be added to both standard and sample solutions when analyzing samples containing variable amounts of the alkali and alkaline earth metals. This should be done even with the air-acetylene flame. The use of an ionization suppressant with the hotter flames is much more desirable than using low temperature flames, with their more serious chemical interferences. (See also W71-03380). (Knapp-USGS)

W71-03386

#### THE OLENTANGY AND SCIOTO RIVERS AT COLUMBUS, OHIO,

Ohio State Univ., Columbus, Ohio. Dept. of Geology; and Ohio State Univ., Columbus, Ohio. Water Resources Center.

Rene Eastin, and G. Faure.

Ohio Journal of Science, Vol 70, No 3, p 170-179, May 1970. 10 p, 4 fig, 2 tab, 17 ref. OWRR Project No B-004-Ohio (2).

Descriptors: \*Solutes, \*Water quality, \*Ohio, \*Water chemistry, Surface waters, Calcium, Sodium, Potassium, Strontium radioisotopes, Limestones, Discharge (Water), Streamflow.  
Identifiers: \*Scioto River (Ohio), \*Olentangy River (Ohio).

Concentrations of sodium, potassium, calcium, and strontium were determined in water samples collected from the Olentangy and Scioto Rivers at Columbus, Ohio, during 1966. The water samples were collected at weekly intervals throughout the year and were combined into four-week composites. The average concentrations in the Olentangy River (in units of micrograms/ml) were: Na, 22.3; K, 3.3; Ca, 72.4; Sr, 0.923. In the Scioto River the concentrations of these elements were: Na, 12.2; K, 3.6; Ca, 78.8; Sr, 1.91. In both rivers the concentrations of sodium and strontium decreased linearly with increasing discharge, whereas the concentrations of potassium and calcium did not. The concentration of potassium increased steadily during the summer and reached a peak in the fall. The Sr-87/Sr-86 ratio of the Olentangy River decreased with increasing discharge from 0.7116 to 0.7088 while that of the Scioto River appeared to be constant at 0.7093. (Knapp-USGS)

W71-03390

#### VACUUM UV ABSORPTION SPECTRA OF LIQUID WATER AND ICE,

Ryumyo Onaka, and Tsutomu Takahashi.

Journal of Physical Society of Japan, Vol 24, No 3, p 548-550, March 1968. 3 p, 5 fig, 18 ref.

Descriptors: \*Water properties, \*Absorption, \*Spectroscopy, \*Ultraviolet radiation, Crystallography, Hydrogen bonding, Physical properties, Spectrometers.

Identifiers: \*Ultraviolet spectrometry (Water).

Fundamental absorption bands of ice and liquid water were studied. Cubic ice has a well-defined absorption band at about 8.7 eV, while hexagonal and amorphous ices show only a gradual increase of absorption intensity toward the higher energy in the range from 7 to 10 eV. Absorption coefficient of liquid water is found to comply with the Urbach rule at the low energy tail of the fundamental absorption. (Knapp-USGS)

W71-03431

#### SOLUBILITY AND DISSOLUTION RATE OF AMORPHOUS SILICA IN DISTILLED AND SEA WATER AT 20 DEG C.

Nagoya Univ. (Japan). Water Research Lab.

Kikuo Kato, and Yasushi Kitano.

Journal of the Oceanographical Society of Japan, Vol 24, No 4, p 147-152, August 1968. 6 p, 4 fig, 1 tab, 18 ref.

Descriptors: \*Aqueous solutions, \*Silica, \*Water chemistry, \*Sea water, \*Solubility, Solutes, Hydrogen ion concentration, Chemical properties, Saturation, Salinity.

Identifiers: \*Silica solubility.

The solubility of amorphous silica in sea water is about 85 mg per liter at 20 deg C, which is less than that in distilled water (about 113 mg per liter). The dissolution rate seems to be controlled by the amount of silica gel present and its solubility. Silica gel in sea water is transformed to dissolved silica at a much faster rate than in distilled water. A maximum value of dissolved silica is observed during the process of dissolution without abrasion, when the dissolution rate is very large. The differences in

the solubility and in the dissolution rate of amorphous silica in distilled and in sea water cannot be explained by the difference in pH values of the waters but seem to be related to the salts present in sea water. (Knapp-USGS)

W71-03436

#### GEOCHEMICAL STUDY OF GROUNDWATERS IN THE MATSUSHIRO AREA - PART 2: CHEMICAL COMPOSITION OF GROUNDWATERS,

Nagoya Univ. (Japan). Water Research Lab.

Yasushi Kitano, Ryuma Yoshioka, Setsuo Okuda, and Kazuo Okunishi.

Kyoto University Disaster Prevention Research Institute Bulletin, Vol 18, Part 1, No 133, p 49-58, May 1968. 10 p, 7 fig, 8 ref.

Descriptors: \*Earthquakes, \*Water quality, \*Springs, \*Water sources, \*Water chemistry, Geology, Hydrogeology, Landslides, Water circulation, Aquifers, Groundwater, Groundwater movement, Geochemistry.

Identifiers: \*Japan, \*Matsushiro (Japan).

A hydrological survey and chemical analysis of groundwaters in the Matsushiro area between September 1966 and February 1968 was made to study chemical quality changes caused by the earthquakes of 1965. Water balance and chemical composition of groundwaters in the area show that groundwaters have a deep source and that they are not influenced by recent precipitation. There is a general tendency for the concentrations of calcium and chloride ions, among dissolved ions, to increase with time. A positive relationship between the activity of the swarm earthquakes, the amount and the concentration of the chemical composition of groundwaters in the area was observed. Many of the springs which gushed out accompanying the heavy earthquakes and landslides disappeared entirely after a decrease in their discharge, whereas large amounts of water are still discharging from some springs. (Knapp-USGS)

W71-03437

#### STREAM TEMPERATURE STUDY, NORTH FORK SNOQUALMIE RIVER, WASHINGTON,

Washington Univ., Seattle. Charles W. Harris Hydraulics Lab.

E. Ronald Nece.

OWRR Project A-012-WASH (1). State of Washington Water Research Center, Completion Report, January 1968. 49 p, 10 fig, 4 tab, 11 ref. Technical Report No 23.

Descriptors: \*Water temperature, \*Micrometeorology, \*Streams, \*Solar radiation, \*Air temperature, Hydrology, Groundwater flow.

Identifiers: \*Stream water temperature, \*Groundwater temperatures.

The upper basin of the North Fork of the Snoqualmie River was used to study stream temperatures in the headwater regions of a typical Pacific Northwest mountain River. One objective was to see if relatively simple calculation methods could be devised for formulating predictions of stream temperature in the upper reaches of such rivers. This involved consideration of the temperature of the groundwater flow. Measurements of air temperatures and of solar radiation in the test basin were performed and a check was made to verify the assumption that these variables may be predicted on the basis of conventional data obtained from regional weather stations. Field data obtained and attempts to develop a computational procedure for predicting stream temperature variations as function of assumed climatological conditions and streamflows are described. The question of transfer of some climatological data from one area to another was checked in more detail; results are presented and discussed. (Herrera-Vanderbilt)

W71-03481

#### SEASONAL VARIATION OF THE SOLUTE CONTENT AND THE Sr-87/Sr-86 RATIO OF

## Field 02—WATER CYCLE

### Group 2K—Chemical Processes

**FRACTIONATION OF PHOSPHATE IN A MATURITY SEQUENCE OF NEW ZEALAND BASALTIC SOIL PROFILES: I,**  
Lincoln Coll., Canterbury (New Zealand).  
For primary bibliographic entry see Field 02G.  
W71-03482

**FRACTIONATION OF PHOSPHATE IN A MATURITY SEQUENCE OF NEW ZEALAND BASALTIC SOIL PROFILES: 2,**  
Lincoln Coll., Canterbury (New Zealand).  
For primary bibliographic entry see Field 02G.  
W71-03483

**SIGNIFICANCE OF SILICA IN THE LOSS OF MAGNESIUM FROM IRRIGATION WATERS,**  
California Univ., Riverside.  
Frank M. Eaton, G. W. McLean, G. S. Bredell, and  
H. E. Doner.  
Soil Science, Vol 105, No 4, April 1968, p 260-280. 10 tab, 3 fig, 53 ref. California Water Resources Center Project W202.

Descriptors: \*Calcium, \*Magnesium, \*Silica, \*Drainage water, \*Irrigation water, Water quality, Chlorides, Runoff, Sulfates, Saline soil, Carbonates, Alkalinity, Ion exchange, Sodium, Solubility, Groundwater, California, Rio Grande, Silicates, Arid lands, Rivers, Chemical precipitation, Hydrogen ion concentration, Saline water, Surface waters, Water chemistry, Water analysis, Analytical techniques, Data collections, Electrical conductance.  
Identifiers: \*Soil solution, \*River water.

In this article illustrations show that the tendency for Ca/Mg ratios in saline soil solutions and drainage waters is similar to those in irrigation supplies, though Cl concentrations may increase with runoff. Ca is lost to CaSO sub 4 and CaCO sub 3 precipitation while Mg is lost to silicates as an alkalinity and an ionization function through an increase in Na and CaCO sub 3 precipitation in the alkalinity source. Variations in SiO sub 2 solubilities in river and groundwaters as influenced by discharge, time and temperature are discussed for a California watershed. Tables show silica and average ionic concentrations in the Rio Grande drainage basin; silica, Cl and Ca/Mg ratios for selected sites; long term silica and electrolyte concentrations in California rivers; effects of HCO sub 3 and SiO sub 2 and Ca and Mg precipitation; serial additions of sodium nitrate and silicate effects; pH ranges on sodium carbonates and silicates; factorial summary of Mg losses; and sea water effects. Also included are figures of Mg solubilities in SiO sub 2, SiO sub 2 in Mg as influenced by pH, concentration and time, and solubilities of Mg and SiO sub 2 in MgCl sub 2 and Na sub 2 SiO sub 3. (Popkin-Arizona)  
W71-03494

**SOIL SALINITY IN THE WEST CENTRAL GEZIRA, REPUBLIC OF THE SUDAN,**  
Australian National Univ., Canberra. Research School of Pacific Studies.  
For primary bibliographic entry see Field 02G.  
W71-03499

**CALCIUM ACTIVITY, COMPLEX AND ION-PAIR IN SATURATED CaCO sub 3 SOLUTIONS,**  
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.  
F. S. Nakayama.  
Soil Science, Vol 106, No 6, p 429-434, November 1968. 3 tab, 1 fig, 21 ref.

Descriptors: \*Calcium, \*Calcium compounds, \*Calcium carbonate, \*Equilibrium, \*Stability, Ions, Solutes, Solubility, Soil water, Sierozems, Calcareous soils, Arid lands, Chemical reactions, Hydrogen ion concentration, Soil chemistry, Equations.  
Identifiers: \*Calcium activity, \*Ion activity, Partial pressure.

The behavior of all soil-related Ca compounds is of vital interest to soil scientists, particularly those studying arid and calcareous soils. This paper reports on the different forms of Ca that may be in equilibrium with CaCO sub 3 with their appropriate dissociation or association constants. Constants related to each of the species are K sub 1 equals 0.0564 for the relation positively monovalent CaHCO sub 3 equals positively divalent Ca plus negatively monovalent HCO sub 3, K sub 2 equals 1.245 times 10 to the seventh for CaCO sub 3 plus positively monovalent H equals positively monovalent CaHCO sub 3, and K sub 4 equals 0.329 times 10 to the minus four for CaCO sub 3 equals positively divalent Ca plus negatively divalent CO sub 3. In saturated CaCO sub 3 solution under partial pressure conditions resembling that of atmospheric CO sub 2, suitable correction must be employed to get the actual positively divalent Ca concentration when the Ca activity cannot be measured directly. Activity, concentration and equilibrium values are given in tables. There are 9 equations and a plot of experimental data testing the estimation of the equilibrium equation. (Popkin-Arizona)  
W71-03502

**MEMBRANE FOULING AND STUDIES ON NEW ELECTRODIALYSIS MEMBRANES,**  
Negev Inst. for Arid Zone Research, Beersheba (Israel).

For primary bibliographic entry see Field 03A.  
W71-03522

**DIFFUSION AND ACCUMULATION OF CHLORIDE AND SODIUM IN LAKE ONTARIO, SEDIMENT,**  
Department of Energy, Mines and Resources, Burlington (Ontario). Canada Center for Inland Waters.  
For primary bibliographic entry see Field 02H.  
W71-03672

**SOURCES OF DISSOLVED CARBONATE IN AN AQUIFER FREE OF CARBONATE MINERALS,**  
Geological Survey, Washington, D.C.; Geological Survey, Denver, Colo.

F. J. Pearson, Jr., and Irving Friedman.  
Water Resources Research, Vol 6, No 6, p 1775-1781, December 1970. 7 p, 2 fig, 2 tab, 14 ref.

Descriptors: \*Water chemistry, \*Carbonates, \*Groundwater, \*Provenance, \*Stable isotopes, Water sources, Recharge, Infiltration, Groundwater movement, Solutes, Aquifers.  
Identifiers: \*Long Island (NY).

Water from 14 wells in the Magothy aquifer, Long Island, New York, was sampled for chemical analysis and C-13/C-12 ratio measurements of the dissolved carbonate. The Magothy is essentially free of carbonate minerals and contains water whose chemistry is controlled by the chemistry of the atmospheric precipitation that recharged the aquifer. Wells near the recharge area have delta C-13 values of -2.5% and total carbonate contents corresponding to a PCO2 of about 0.004 atmosphere, showing that the carbonate here is derived from the soil zone. Downgradient, the total carbonate content doubles, but the delta C-13 values remain more negative than -1.8%. The dissolved carbonate increase is due in part to carbonate mineral solution but results largely from oxidation of lignite in the aquifer by oxygen dissolved in the water. (Knappe-USGS)  
W71-03694

**A PORTABLE, AUTOMATIC WATER SAMPLER,**  
Forest Service (USDA), Ogden, Utah. Intermountain Forest and Range Experiment Station.  
For primary bibliographic entry see Field 07B.  
W71-03695

**PHOSPHORUS CONTENT IN UNCONSOLIDATED SEDIMENTS FROM SOUTHERN LAKE MICHIGAN,**  
Illinois State Geological Survey, Urbana.  
For primary bibliographic entry see Field 05A.  
W71-03703

**QUALITY OF SURFACE WATERS OF THE UNITED STATES, 1965: PARTS 5 AND 6. HUDSON BAY AND UPPER MISSISSIPPI RIVER BASINS, AND MISSOURI RIVER BASIN.**  
Geological Survey, Washington, D.C.  
For primary bibliographic entry see Field 07C.  
W71-03707

### 2L. Estuaries

**MODEL STUDIES OF SALT WATER INTRUSION,**  
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.

Abdel-Aziz I. Kashef.  
Water Resources Bulletin, Vol 6, No 6, p 944-967 November-December 1970. 24 p, 14 fig, 10 tab, 31 ref. OWRR Project A-007-NC (6).

Descriptors: \*Saline water intrusion, \*Groundwater movement, \*Hydraulic models, Model studies, Porous media, Viscosity, Hydrodynamics, Hydraulic similitude, Soil water movement, Laboratory tests, Saline water-freshwater interfaces, Steady flow, Unsteady flow.  
Identifiers: \*Hele-Shaw models.

Model studies are used to verify theories in groundwater flow systems. In complex cases, the model studies may be extremely useful especially when a theoretical rigorous analysis does not exist. The models cannot be considered entirely satisfactory due to the several drawbacks in each type in addition to the normal human errors in experimentation. This paper is concerned with viscous flow models. A brief summary of the other types of models, which may be possibly be used in connection with salt water intrusion problems, is also given. Gravity flow systems are analogous to some phases of salt intrusion problems. Problems in oil fields bear general similarities to sea water intrusion zones. In oil fields, gas cycling studies give valuable information to sea water problems. Model studies are used by hydraulic engineers, geologists, petroleum engineers, physicists, foundation engineers and several other professional groups. (Knapp-USGS)  
W71-03316

**TIDAL PRISM MEASUREMENTS AT MOUTH OF COLUMBIA RIVER; HYDRAULIC MODEL INVESTIGATION,**  
Army Engineer Waterways Experiment Station, Vicksburg, Miss.  
For primary bibliographic entry see Field 08B.  
W71-03324

**RELATIONSHIP BETWEEN POLLUTION INDICATOR ORGANISMS AND THE SALINITY OF MISSISSIPPI'S ESTUARINE WATERS,**  
Gulf Coast Research Lab., Ocean Springs, Miss.  
For primary bibliographic entry see Field 05A.  
W71-03387

**A CONTROLLED DEPTH, VOLUMETRIC BOTTOM SAMPLER,**  
For primary bibliographic entry see Field 05A.  
W71-03449

**TEMPERATURE STUDIES OF AN INTERTIDAL ZONE OF AN ESTUARY,**  
Central Electricity Generating Board, London (England).  
For primary bibliographic entry see Field 05B.  
W71-03467

## WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 03

### Water Yield Improvement—Group 3B

UNITED STATES V STEWART (LAND DESCRIBED AS BOUND BY THE WATER'S EDGE IS THAT LAND ABOVE THE MEAN HIGH WATER MARK).  
For primary bibliographic entry see Field 06E.  
W71-03524

SAND WAVES AND TIDAL CHANNELS IN THE ENTRANCE TO CHESAPEAKE BAY,  
Old Dominion Univ., Norfolk, Va. Inst. of Oceanography.  
John C. Ludwick.

Available from NTIS as AD-713 195, \$3.00 in paper copy, \$0.95 in microfiche. Technical Report No 1, September 1970. 107 p, 32 fig, 57 ref. ONR Task Number NR388098.

Identifiers: \*Estuaries, Sand, \*Tides, Chesapeake Bay, Sedimentation, Floods, Ocean waves, Fluid flow, Interactions, Hydrographic surveying, Bathythermograph data, Tidal channels, Shoal development.

Sand waves 5-12 feet in height and 200-1200 feet in length occur in water 25-50 feet deep in the sand bank and tidal channel area of the entrance to Chesapeake Bay. Most waves are asymmetrical in transverse profile, some facing with ebb currents, others facing with flood currents, depending which is dominant at a given place. Steep slopes on the various waves range from 4 deg to 31 deg and average 12 deg. The sand waves occur in association with tidal channels and especially on the flanks of shoals that form channel boundaries. Migration of sand waves, judged from their facing direction, is a bed sediment transport mechanism by which sand is moved up onto shoals. Many large shoals of the area occur between ebb-dominated and flood-dominated channels. This implies the existence of net circulation loops of water and sediment in cells located over shoals. The action of such cells is to trap sediment. Other ebb-flood shear zones may mark sites of future shoaling in the entrance.  
W71-03529

NOTES ON BEACH EROSION IN THE CHARLESTON HARBOR AREA,  
Citadel, Charleston, S.C. Dept. of Chemistry.  
H. D. Wagener.

South Carolina Division of Geology, Environmental Geology Series 1, 1970. 11 p, 2 fig, 1 map.

Descriptors: \*Beach erosion, \*South Carolina, \*Erosion control, Coastal engineering, Shore protection, Surveys, Littoral drift, Provenance, Sediment transport, Surf, Recreation.  
Identifiers: \*Charleston Harbor (SC).

Barrier islands, such as the Isle of Palms, Sullivan's Island and Folly Island, all near Charleston Harbor, South Carolina, change significantly in configuration over periods of several decades. Retreat of the island as a result of beach erosion causes loss of land and property damage almost immediately. Erosion arrestment structures such as the Folly Island groins, the Isle of Palms groin, and the emergency seawall of the Isle of Palms have generally accomplished the purposes for which they intended. Beach erosion and outbuilding of beaches are directly related to the supply and distribution of sand by waves, longshore and other offshore currents, and tidal currents. South Carolina coastal waters are sufficiently shallow that changes in positions of currents, scour channels, offshore bars, etc., could be monitored by use of conventional black and white stereoscopic aerial photography. Photograph studies could be backed up by in situ measurement of current velocities, rates of sand transport, etc. (Knapp-USGS)  
W71-03701

COLLECTIVE MOVEMENT OF SEDIMENT IN LITTORAL ENVIRONMENT,  
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.  
For primary bibliographic entry see Field 02J.  
W71-03715

MARINE AQUACULTURE,  
National Science Foundation, Washington, D.C.  
Office of Science Information Service.  
Tadashi Tamura.

Trans of mono Suisan Zoshokuga Ku, Tokyo, 1966.  
Available from NTIS as PB-194 051, \$15.00 in paper copy, \$0.95 in microfiche. 2nd ed., 1970. 1125 p.

Identifiers: \*Aquaculture, Books, Fisheries, Shallow water, Ecology, Larvae, Growth, Culture media, Food, Marine fishes, Crustacea, Reptiles, Aquatic animals, Cephalopoda, Gastropoda, Echinodermata, Algae, Translations, Japan.

Marine aquaculture and the promotion of coastal fisheries; The present state of marine aquaculture; Techniques in shallow sea cultivation; Environmental factors in marine aquaculture; Ecological factors in the propagation of marine organisms; Artificial hatching, Rearing larvae; Culture ponds; Food; Marine organisms aquacultured in Japan; Propagation of reptiles; Propagation of marine fishes; Propagation of ascidians; Propagation of crustaceans; Propagation of cephalopods; Propagation of gastropods; Propagation of bivalves; Propagation of echinoderms; Propagation of other marine animals; Propagation of algae.  
W71-03772

MAINE LAW AFFECTING MARINE RESOURCES, VOLUME III: REGULATION OF THE COAST: LAND AND WATER USES.  
Maine Univ., Portland. School of Law.  
For primary bibliographic entry see Field 06E.  
W71-03785

### 03. WATER SUPPLY AUGMENTATION AND CONSERVATION

#### 3A. Saline Water Conversion

POWER, WATER AND FOOD FOR DESERT COASTS: AN INTEGRATED SYSTEM FOR PROVIDING THEM,  
Arizona Univ., Tucson.

Carl H. Hodges, and Carle O. Hodge.  
66th Annual Meeting, American Society for Horticultural Science, Pullman, Washington, August 20-22, 1969. Typescript 20 p.

Descriptors: \*Desalination, Waste disposal, Water sources, \*Desalination plants, Heat, Environment, Environmental engineering, Ecology, Biological communities, \*Coasts, Deserts, \*Arid lands.  
Identifiers: Waste heat utilization.

Of the world's 20,000 miles of arid coastline, a large percentage remains benefit of cultivation. Considerable portions of these sparse areas could be made productive if the basic amenities of life were present. On this premise, investigations were started in November 1966 on possible designs for an economical package for power-water-food production in such locations. An integrated, closed-environment system has been devised. Waste heat from engine-driven electric generator sets is used to desalt seawater. This fresh water, in turn, is utilized for the irrigation of vegetables planted within greenhouses of air-inflated plastic. High-quality vegetables have been grown in a pilot facility on the Gulf of California while planning has begun for the first large-scale installation--in the Arabian Peninsula Shaikdom of Abu Dhabi. The concept is believed to be widely applicable.  
(Novotny-Vanderbilt)  
W71-03465

ADVANCED WASTE TREATMENT BY DISTILLATION,  
Badger (W. L.) Associates, Inc., Ann Arbor, Mich.  
For primary bibliographic entry see Field 05D.  
W71-03509

COST OF PURIFYING MUNICIPAL WASTE WATERS BY DISTILLATION,  
Delaware Univ., Dover.

For primary bibliographic entry see Field 05D.  
W71-03510

MEMBRANE FOULING AND STUDIES ON NEW ELECTRODIALYSIS MEMBRANES,  
Negev Inst. for Arid Zone Research, Beersheba (Israel).

F. de Korosy, A. Suszer, E. Korngold, M. F. Taboch, and M. Flitman.  
For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 Price \$1.00. Office of Saline Water Research and Development Progress Report No. 605, December 1970. 102 p, 17 fig, 6 tab, 38 ref. OSW Contract 14-01-0001-1734.

Descriptors: Desalination, \*Membrane processes, \*Electrodialysis, \*Electrochemistry, Ion Exchange Membranes, Permselective Membranes, Ion transport, Scale prevention, Scale deposition.  
Identifiers: Membrane fouling, Membrane scaling.

The main objectives of the experiments described were the detailed observation of the fouling of anionselective membranes by colloids, the understanding of the mechanism of this phenomenon and, if possible, its elimination or alleviation. The fouling characteristics of various existing membranes as well as synthesized new ones were determined in an effort to find membranes that would be less prone to fouling. Bimolecular leaflet membranes were examined to give a better understanding of the phenomena occurring on the surface of membranes. (Kindley-Office of Saline Water)  
W71-03522

#### POND LININGS FOR DESALTING PLANT EFFLUENTS.

Bureau of Reclamation, Denver, Colo. Div. of Research.  
For primary bibliographic entry see Field 05G.  
W71-03523

#### EVALUATION OF PYRRONES AS MEMBRANES,

Franklin Inst. Research Labs., Philadelphia, Pa.  
For primary bibliographic entry see Field 05D.  
W71-03780

#### 3B. Water Yield Improvement

ON ICE NUCLEATING PROPERTIES OF DIFFERENT FACES OF SILVER IODIDE CRYSTALS,  
Nagoya Univ. (Japan). Water Research Lab.  
K. Isono, and Y. Ishizaka.  
Journal de Recherches Atmosphériques, Vol 3, p 139-140, 1968. 2 p, 1 fig, 1 ref.

Descriptors: \*Chemistry of precipitation, \*Cloud seeding, \*Crystallography, \*Nucleation, \*Silver iodide, Ice, Supercooling, Freezing, Condensation, Crystal growth, Crystals.  
Identifiers: Supercooled clouds.

To clarify the mechanism of ice nucleation, experiments were conducted on ice nucleation on silver iodide films and particles. Specimens of silver iodide films to be used were examined with an electron microscope to determine crystal structures before experiments. Each sample of silver iodide film was mounted on a copper rod cooled with a Peltier element. Temperature and dew point on the surface of the samples were controlled. Below -8 deg C and below water saturation, ice crystals were nucleated on prism faces of AgI, whereas above water saturation ice crystals were nucleated from supercooled water droplets on both basal and prism faces, preferentially on the basal. The silver iodide films were deposited on the basal plane of muscovite crystals with special care that most films

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were so orientated that their basal faces were parallel to the basal faces of muscovite. (Knapp-USGS) W71-03430

**EFFECTS OF A MONOLAYER ON RESERVOIR TEMPERATURE AND EVAPORATION,**  
Army Electronics Command, Fort Huachuca, Ariz.  
Atmospheric Science Lab.  
Jon F. Bartholic, Jack R. Runkles, and Ernest B. Stenmark.  
*Water Resources Research*, Vol 3, No 1, p 173-179, First quarter 1967. 3 fig, 1 tab, 12 ref.

Descriptors: \*Water temperature, \*Evaporation control, \*Monomolecular films, \*Reservoir evaporation, Water conservation, \*Temperature, Water balance, Energy budget, Mass transfer.

Since a considerable portion of the available supply of water is stored in reservoirs, emphasis has been placed on preserving this water for future use. It is the purpose of this paper to evaluate the effectiveness of a monolayer in retarding evaporation from the surface of a reservoir by means of three approaches, such as: the water-budget method, the energy-budget, mass-transfer method and the U. S. Bureau of Reclamation simplified method (U. S. B. R.). The application of a monolayer to a reservoir water surface to reduce evaporation showed a relative rise in the water temperature not only at the surface, but also at greater depths. It is stated that this increase in temperature must be accounted for in predicting the reduction in evaporation by monolayers. Neglecting this change in temperature, the corresponding change in vapor pressure and using only the temperature actually measured after film application, results in evaporation reduction estimates by the U. S. B. R. simplified method, which estimates are found to be 8 to 14% too large. (Herrera-Vanderbilt) W71-03473

**POSSIBLE EFFECTS OF PRECIPITATION MODIFICATION ON STREAM CHANNEL GEOMETRY AND SEDIMENT YIELD,**  
Pennsylvania State Univ., University Park.

Albert Rango.

*Water Resources Research*, Vol 6, No 6, p 1765-1770, December 1970. 6 p, 1 fig, 3 tab, 11 ref. Bur. of Reclamation Contract 14-06-D-6467.

Descriptors: \*Weather modification, \*Rainfall-runoff relationships, \*Channel morphology, \*Sediment yield, Sediment transport, Bed load, Scour, Stream erosion, Suspended load, Data collections, Hydrologic data, Regression analysis, Simulation analysis, Mathematical models, Sampling, Discharge (Water).

Identifiers: \*Channel geometry.

Stream channel geometry data were collected on 18 small watersheds in the West and sediment yield data were obtained for 673 small watersheds across the United States. Regression analysis was used to test what effects precipitation modification might have on these watershed parameters. No consistent changes of stream channel geometry between watershed areas were obtained, but the results indicated that the stream channel at a given location would adjust significantly in response to increases in precipitation (amounting to 14% annually). This response would probably initiate increased stream channel erosion. Sediment yield will increase substantially in semiarid regions with increasing precipitation until about 27 inches mean annual precipitation; at this point vegetation growth as a result of increased precipitation will begin to reduce sediment yield. Significant changes in stream channel geometry and sediment yield may result in sufficient economic damage to nullify many of the beneficial effects of weather modification. (Knapp-USGS) W71-03693

**SOME GENERAL COMMENTS ON THE SYNERGISTIC RUNOFF EFFECT FROM JOINT**

**WATERSHED MANAGEMENT AND WEATHER MODIFICATION,**  
State Univ. of New York, Syracuse. Water Resources Center.  
For primary bibliographic entry see Field 02A. W71-03696

modern agricultural techniques and increased spread of human and plant disease vectors due to increased irrigation. Nevertheless it appears that the transition from the traditional economy is largely successful. (Casey-Arizona) W71-03333

### 3C. Use of Water of Impaired Quality

**SIGNIFICANCE OF SILICA IN THE LOSS OF MAGNESIUM FROM IRRIGATION WATERS,**  
California Univ., Riverside.  
For primary bibliographic entry see Field 02K. W71-03494

### 3D. Conservation in Domestic and Municipal Use

**DETERMINATION OF THE SIGNIFICANCE OF VARIABLES AFFECTING RESIDENTIAL WATER CONSUMPTION,**  
Puerto Rico Univ., Mayaguez. Water Resources Research Inst.

For primary bibliographic entry see Field 06D. W71-03517

**WATER AND CITIES AND INDUSTRIES,**  
Hazen and Sawyer, New York.  
For primary bibliographic entry see Field 06D. W71-03595

### 3E. Conservation in Industry

**WATER AND CITIES AND INDUSTRIES,**  
Hazen and Sawyer, New York.  
For primary bibliographic entry see Field 06D. W71-03595

### 3F. Conservation in Agriculture

**CHANGING AGRICULTURAL PRACTICE IN AN ARABIAN OASIS; A CASE STUDY OF THE AL'AIN OASIS, ABU DHABI,**  
Durham Univ. (England). Dept. of Geography.  
J. H. Stevens.  
*Geographical Journal*, Vol 136, No 3, p 410-418, September 1970. 3 fig, 10 ref.

Descriptors: \*Irrigation practices, \*Arid lands, \*Regional analysis, \*Social impact, \*Economic impact, Cultivated lands, Crop production, Forages, Dates, Trees, Economic efficiency, Climatic data, Hydrologic data, Soil types, History, Social adjustment, Area redevelopment, Social change, Agriculture, Seasonal, Resource development, Irrigation water, Vegetable crops, Diversification.

Identifiers: \*Trucial states, \*Abu Dhabi, \*Oases, \*Underdeveloped lands, \*Agricultural evolution, Africa, Oasis agriculture.

Abu Dhabi is one of the 7 Trucial states and has a large national income from oil. Major development projects have concentrated on communications, industry and municipalities. However, due to an increasing population and greater national wealth, the agricultural sector has increased in size and has become more diversified and more commercially oriented. Most of the agriculture is concentrated around a few small strings of oases and expansion has been through the drilling of irrigation wells in these areas. The traditional small date gardens (less than 1 ha) have been surrounded by many small holdings (20-25 dunums) and several large units (15-100 ha). This has been accompanied by crop diversification into income-yielding vegetables and forages (mainly lucerne). The rather swift agricultural changes have been accompanied by some social consequences - seasonal market gluts of vegetables, inefficiencies due to ignorance of

**WILDLIFE V SHEEP AND CATTLE IN AFRICA,**  
Leslie Brown.  
*Oryx*, Vol 10, No 2, p 92-101, September 1969. 4 fig.

Descriptors: \*Grazing, \*Wildlife, \*Domestic animals, \*Rainfall, \*Grasslands, Habitats, Agriculture, Humid climates, Semiarid climates, Arid climates, Food abundance, Food chains, Food habits, Animal behavior, Population, Ecology, Economic efficiency, Damages, Economic feasibility, Economic justification, Environmental effects, Erosion, Social impact, Animal diseases, Animal populations, Wildlife management, Diseases, Range management, Forests, Productivity, Biomass, Proteins, Sheep, Cattle.  
Identifiers: \*Africa, \*Pastoral cultures, \*Nomadic cultures, \*Wildlife harvesting, Tsetse flies.

A modern paradox is that while man, at least in Africa, systematically eliminates native wildlife in the process of agricultural development, hardly any natural areas have been destroyed by wildlife. Virtually every area inhabited by man and his domestic animals has been methodically and seriously damaged. Three types of African grasslands are distinguished on the basis of rainfall. Agricultural activities in each area must vary because of differing productivities. Highest rainfall areas (35-40 ins/yr) are also the highest agricultural productivity areas and elimination of most wildlife is probably justified. However, inefficient cultivation and soil conservation practices in these areas lead to the shifts in human population to lower rainfall areas and consequent destruction of vital wildlife habitats. It is argued that crucial economic factors are ignored in exploitation of low-rainfall areas. Because of adaptation to a wider variety of plants, more efficient water conservation mechanisms, greater disease resistance and adaptive population restriction mechanisms, which avert overgrazing, wild animals may be more economical protein producers than domestic animals. Nomadic practices in arid regions, systematic wildlife harvesting, elimination of expensive tsetse fly eradication programs and more realistic economic evaluation are suggested. (Casey-Arizona) W71-03341

**CLIMATE, PESTS AND AGRICULTURE,**  
Gatooma Research Station (Rhodesia).

F. E. M. Gillham.  
Agroclimatological Methods; Proceedings of the Reading Symposium, Natural Resources Research, Vol 7, p 131-139, UNESCO, 1968. 35 ref.

Descriptors: \*Insects, \*Crop response, \*Ecological distribution, \*Insect control, \*Environmental effects, Winds, Temperature, Rainfall, Agronomy, Food habits, Food webs, Agriculture, Insect behavior, Insecticides, Biocontrol, Chemcontrol, Insect attractants, Ecosystems, Insect resistance, Cotton, Pest control, Population, Climatology, Microenvironment, Microclimatology, Irrigation effects, Predation, Economic feasibility, Life history studies, Ecology, Dispersion, Physiological ecology.

Identifiers: \*Agroclimatology, \*Bioclimatology, Adaptation.

Insect specialization has been evolving for at least 250 million years and has been characterized by adaptive responses to competition resulting in evolution from polyphagous to oligophagous to the very specialized monophagous feeding habits. The rise of agriculture with its intensive one-crop concentration has provided optimal environments to highly specialized insects in which the normal population regulatory mechanism of food limita-

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tion has been removed. Emphasis is placed on the dynamic relationship between the insect predator and its plant host so that control studies must include a thorough knowledge of the biology of both. Temperature, rainfall and wind are critical climatic factors affecting insect populations, and these interact with the unique biology of a given crop plant and surrounding edaphic conditions. Additionally, microclimatology may differ greatly from macroclimatology and should be taken into consideration in any study of crop ecosystems. Agronomic factors such as irrigation will create changes in local ecosystems which must be thoroughly assessed in terms of potential effects on pest populations. Various methods of insect control are outlined and it is stressed that they should not cancel out each other or exceed economic feasibility. (Casey-Arizona) W71-03347

#### WEATHER AND PLANT DISEASE FORECASTING, Weather Bureau, Tifton, Ga. Agricultural Service Office.

V. J. Valli.

Agroclimatological Methods; Proceedings of the Reading Symposium, Natural Resources Research, Vol 7, p 341-346, UNESCO, 1968. 2 tab, 18 ref.

Descriptors: \*Plant diseases, \*Weather, \*Forecasting, \*Plant pathology, Temperature, Rainfall, Winds, Humidity, Seasonal, Light, Potatoes, Blights, Apples, Scabs, Pecans, Tobacco, Molds, Beans, Mildews, Peanuts, Environmental effects, Infection, Pathogenic fungi.  
Identifiers: \*Agroclimatology, \*Bioclimatology.

One of the most elementary and generally valid principles of plant pathology is that bioclimate (weather and soil conditions) influences seasonal development and geographic distribution of plant diseases. The 3 most influential components of the bioclimate are wind, relative humidity, and temperature. Severity of an outbreak of disease is a function of bioclimate, susceptible plant vulnerability and pathogen virulence. Examples are given of specific diseases, their meteorological criteria, methods of forecasting their occurrences or spread, and actual advisories issued. (Casey-Arizona) W71-03348

#### ULTIMATE DISPOSAL OF PHOSPHATE FROM WASTE WATER BY RECOVERY AS FERTILIZER, Grace (W. R.) and Co., Clarksville, Md. For primary bibliographic entry see Field 05D. W71-03459

#### BENEFICIAL USES OF THERMAL WATER, Vitro Corp. of America, Portland, Oreg. Portland Operation. For primary bibliographic entry see Field 05C. W71-03471

#### A STUDY OF EVAPORATION SUPPRESSANTS UNDER GREENHOUSE CONDITIONS: EVALUATIONS I TO IV, Texas Agricultural Experiment Station, College Station. For primary bibliographic entry see Field 02D. W71-03485

#### INTERROW WATERSHEDS, Texas Agricultural Experiment Station, College Station. J. R. Mulkey, Jr. Texas A and M University, Texas Agricultural Experiment Station, Progress Report 2619, 1968, p 7-10. 4 fig, 2 tab.

Descriptors: \*Agricultural watersheds, \*Planting management, \*Water utilization, \*Cotton, \*Crop production, Water conservation, Water management (Applied), Texas, Rainfall, Soil moisture, Cultivation, Soil-water-plant relationships, Arid lands.

lands, Small watersheds, Dry farming, Fallowing, Fibers (Plant), Spatial distribution, Moisture availability, Data collections, Surface runoff.  
Identifiers: \*Interrow watersheds, \*Skip-row planting, \*Fallow rows, Texas Rolling Plains, Semiarid lands.

Establishing interrow watersheds in skip-row planted cotton was investigated at Chillicothe, Texas, from 1965 to 1967. Cotton lint yields increased 151 pounds per acre in normal rainfall years when planted in two fallow rows, in a two in-two out skip row pattern. The rows were ridged and covered with a plastic fabric, forming an interrow watershed. Interrow watersheds increased available soil moisture in the Texas Rolling Plains. Available water is the most limiting factor for producing cotton fiber in arid and semiarid lands. Figures show dryland cotton under conventional and interrow watershed cultivation. Tables include rainfall and lint yield data. (Popkin-Arizona) W71-03486

#### THREE METHODS OF WATER CONSERVATION FOR DRYLAND COTTON PRODUCTION, Texas Agricultural Experiment Station, College Station.

P. T. Marion.

Texas A and M University, Texas Agricultural Experiment Station, Progress Report 2620, 1968, p 10-12. 3 fig, 1 tab, 3 ref.

Descriptors: \*Cotton, \*Land forming, \*Water conservation, \*Crop production, \*Dry farming, Land management, Contour farming, Slopes, Soil-water-plant relationships, Texas, Terracing, Soil moisture, Soil water, Runoff, Water utilization, Bench leveling, Contour furrows, Depth, Moisture availability, Agricultural watersheds, Water management (Applied).  
Identifiers: \*Cotton lint, \*Row spacing, Border spacing, Semiarid lands.

The Texas A. and M. University Research Station at Spur has used several water conservation methods since 1927. Closed-end contour terraces, which hold all the water that falls on the land, were compared with contoured rows and sloping rows. Contour terracing increased available moisture and lint cotton yield. Land leveling between terraces increased crop production. Runoff water utilization of leveled terraces effected the greatest crop production increase. Bench leveling using parallel borders (8 to 16 rows apart) produced a uniform crop without increasing available soil moisture or cotton lint yield. Close border spacing was a disadvantage. A new parallel terrace system was constructed with terraces spaced 64 rows apart on leveled land. The crop was more uniform and field work was facilitated, although there was no increase in crop production. Figures show effect of depth of soil moisture at planting time, uniform water spread and crop production over a leveled terrace. A table compares parallel leveled terracing, contour non-leveled terracing and contributing level watershed in terms of total acreage, planting pattern and lint yields. (Popkin-Arizona) W71-03487

#### STRAW MANAGEMENT-NITROGEN TREATMENT INVESTIGATIONS IN THE CONTINUOUS PRODUCTION OF IRRIGATED WINTER WHEAT, Southwestern Great Plains Research Center, Bushland, Tex. John Shipley, J. S. Wehrly, and Cecil Regier. Texas A and M University, Texas Agricultural Experiment Station, Progress Report 2706, October 1969. 17 p, 1 fig, 7 tab, 6 ref.

Descriptors: \*Crop production, \*Wheat, \*Nitrogen, \*Soil-water-plant relationships, \*On-site investigations, Burning, Fertilization, Texas, Sampling, Treatment, Irrigation water, Infiltration, Organic matter, Weight, Proteins, Soil analysis, Economic feasibility, Crop response, Farm management, Soil aggregates, Data collections.

Identifiers: \*Straw management, \*Irrigated crops, \*Soil working, \*Mechanical removal, Replications, Semiarid lands, Plots.

A 15-year study began at Etter, Texas, in 1964 to test long-range effects of removing straw from land cropped continuously to irrigated winter wheat. Results from 1965 to 1969 are discussed. Three straw management treatments and 2 replications were applied, including straw working into soil, mechanical removal (simulated bailing) and burning. Treatment plots contained 12 subplots, where 6 nitrogen rates were replicated twice and randomized. Worked-in, removal and burning treatments produced 41.6, 44.5 and 46.8 bushels per acre. Yields from burning and removal treatments were significantly higher than incorporation treatments. Yields did not respond to nitrogen fertilizer, though effects of airborne waste products from a nearby ammonium nitrate plant were probable. Figures and tables show wheat straw yield, treatment, infiltration rate, protein analysis, and soil sample analysis. (Popkin-Arizona) W71-03488

#### THE EFFECT OF ROW SPACING AND PLANT POPULATION ON IRRIGATED CORN PRODUCTION,

Texas Agricultural Experiment Station, College Station.

K. B. Porter, G. W. Grogan, G. L. Peterson, and W. W. Watson.  
Texas A and M University, Texas Agricultural Experiment Station, Progress Report 2724, February 1969, p 22-29. 3 tab.

Descriptors: \*Plant populations, \*Corn (Field), \*Crop production, \*Grains (Crops), \*Spatial distribution, Forages, Texas, Irrigation efficiency, Weight, Water conservation, Sampling.  
Identifiers: \*Row spacing, \*Irrigated crops, \*DeKalb XL 45, \*Texas 40, \*Ear weight, Plots, Semiarid lands, Texas High Plains.

Optimum row spacings and plant populations for growing irrigated corn on the Texas High Plains were investigated. DeKalb XL 45 averaged 98.6 bushels per acre, regardless of plant population factors of 18, 24 and 30 thousand plants per acre. Texas 40 averaged 80.4 for 18, 57.9 for 24, and 51.8 bushels per acre for 30 thousand plant populations. Row spacings did not greatly affect grain yield. Texas 40 forage production was not affected by row spacing or plant population, though 40-inch spacing produced greater ear weight than did narrower spacings. Greater forage ear weights were produced from 18 thousand plant populations than higher populations. Tables show row spacing and plant population effects on grain yield and forage production for irrigated corn in the 1969 tests at Bushland, Texas. (Popkin-Arizona) W71-03489

#### CORN IRRIGATION FIELD STUDY IN MULESHOE AREA, 1969,

Texas Agricultural Experiment Station, College Station.

Leon New.  
Texas A and M University, Texas Agricultural Experiment Station, Progress Report 2725, February 1969. 4 fig, 1 tab.

Descriptors: \*Corn (Field), \*Irrigation practices, \*Irrigation efficiency, \*Crop production, \*Water management (Applied), Moisture stress, Growth stages, Consumptive use, Soil-water-plant relationships, Texas, On-site investigations, Timing, Rates of application, Leaves, Frequency, Variability, Sampling, Analytical techniques, Soil moisture, Spatial distribution, Depth, Data collections, Rainfall, Water requirements.  
Identifiers: \*Row irrigation, \*Growing season, Mixed soils, Texas High Plains, Semiarid lands.

Corn irrigation was investigated in 9 fields in the Muleshoe, Texas, area during the 1969 growing season to determine irrigation management in-

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fluence. Number, amounts and timing of irrigation were evaluated to find important management guides for High Plains growers seeking to improve irrigation efficiency in corn production. Three irrigations applied between the 10 leaf growth and the milk stage of kernel development produced the highest yields. Water application allowed only limited to zero moisture stress during growth stages. Highest average yield was 1,835 pounds per irrigation with 4 irrigations. The number of irrigations varied from 4 to 7 and yields from 6,800 to 8,700 lbs./acre. Alternate row irrigation can be used in mixed soils to speed up water application frequency. The timing of irrigation is more important than the amount of water. Tables and figures show number and amount of irrigation and yield and effects of timing, number and depth of irrigation. (Popkin-Arizona)

W71-03490

#### AN IRRIGATION TREATMENT-YIELD STUDY WITH CORN GROWN ON THE TEXAS HIGH PLAINS,

Texas Agricultural Experiment Station, College Station.

O. C. Wilke, and R. R. Allen.

Texas Agricultural Experiment Station, Texas A and M University, Progress Report 2726, February 1970. 9 p, 2 tab, 2 fig, 1 ref.

Descriptors: \*Corn (Field), \*Irrigation effects, \*Crop production, \*Moisture stress, \*Soil-water-plant relationships, Growth stages, Irrigation efficiency, Moisture tension, Irrigation practices, Crop response, Plant growth, Soil moisture, Moisture availability, Tensiometers, Texas, Arid lands, Data collections, Treatment, Clay loam, Plant populations, Leaves, Moisture content.

Identifiers: \*Maximum yields, Texas High Plains.

Corn (DeKalb XL45) planted in 30-inch rows in Pullman clay loam at Bushland, Texas, was subjected to 9 different irrigation treatments based on stage of plant development. Plant populations and moisture regimens were not optimum for maximum yields. Moisture stress during the silking and pollination period was most injurious to yields. Visual symptoms of stress—crinkling of leaf edges and dying of lower leaves—were apparent in some instances when the soil water content in the top 4 feet of soil was 28 to 30 percent by volume. Soil moisture tensiometers operated satisfactorily in the Pullman clay loam at soil moisture tensions less than 70 centibars. To obtain maximum yields of corn, the soil moisture tension at the 12-inch depth should be less than 70 centibars. Data was not sufficient to verify Taylor's root-zone soil moisture tension of 50 centibars for maximum corn production. Tables and figures show corn irrigation treatments and yields; effect on stage of plant development of yield response and irrigation efficiency; stress days versus corn yield and changes in soil moisture tensions on dryland and irrigated corn with time. (Popkin-Arizona)

W71-03492

#### CORN DATE-OF-PLANTING AND IRRIGATION TIMING STUDY,

Texas Agricultural Experiment Station, College Station.

John Shipley, and Cecil Regier.

Texas Agricultural Experiment Station, Texas A and M University, Progress Report 2727, February 1970. 7 p, 4 tab, 2 ref.

Descriptors: \*Corn (Field), \*Timing, \*Growth stages, \*Irrigation effects, \*Crop response, Soil-water-plant relationships, Irrigation practices, Crop production, Plant growth, Moisture stress, Smuts, Texas, Mature growth stage, Irrigation water, Rates of application, Water requirements, Water utilization, Data collections, Planting management, Consumptive use, Flexibility, Varieties, Scheduling. Identifiers: \*Texas High Plains, Limited irrigation, Hybrids.

Three hybrid corn varieties (DeKalb XL 45, Agrow 204, Texas 40), each representing a different maturity group, were evaluated under 3 different irrigation timing schedules based on growth stage on 4 separate planting dates (1 April, 15 April, 1 May, 19 May). The relatively low yields can be explained partly by moderate to severe moisture stress experienced by all groups during the silking-pollination period and by the smut in some varietal subplots. Although this report covers only one year's results, the data indicate that irrigated corn can be produced over a wide range of planting dates in the High Plains. This range permits corn and grain sorghum to be compatible under limited irrigation water conditions. If the 5 post-plant irrigations scheduled in this study are assumed to be accurate, results justify application of irrigation water when the variety reaches the growth stage specified. Tables present yields of several hybrids under various irrigation timing schedules, general agronomic data, number of days to reach specified growth stages and stages of growth versus period of high consumptive water use. (Popkin-Arizona)

W71-03493

Descriptors: \*Seepage, \*Mississippi River, \*Bank stability, \*Numerical analysis, Viscous flow, \*Model studies, Slope stability.

Identifiers: \*Finite element method.

Design of stable riverbank slopes along Mississippi River is dependent upon seepage conditions within the banks. Because available seepage analyses are not adequate for determining changing free-water surface, a parallel plate viscous flow model was constructed, tested, and found to be a reliable means of obtaining the transient free surface within a sloping bank. Two series of model tests were performed using a vertical upstream face and an upstream slope of 45 deg. Because experimental results are suitable only for simple boundary conditions and for homogeneous banks, some analytical techniques were developed for use with more complex conditions. The finite difference and the finite element methods provide efficient numerical techniques for obtaining numerical solutions. There was good agreement between the two when comparing numerical results with those obtained from experiments with the model. Basic formulation of the finite element method was developed and is included in this report. (Spivey-WES)

W71-03320

#### NAVIGATION PROBLEMS AT CHINCOTEAGUE INLET, VIRGINIA.

Corps of Engineers, Washington, D.C. Committee on Tidal Hydraulics.

Printed at U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, September 1970. 13 p, 3 pl.

Descriptors: \*Shoals, Channel improvement, \*Navigation conditions, Dredging, Inlets (Waterways), Virginia.

Identifiers: \*Chincoteague Inlet, Va.

Navigation problems created by littoral drift and shoaling at Chincoteague Inlet were brought before the Committee on Tidal Hydraulics. Basic question was whether provision of a channel 12 ft deep and 300 ft wide for fishing boats and pleasure craft was economical and physically feasible. It was concluded that a satisfactory channel would be difficult and expensive to construct and maintain. Alternates to the plan are presented. It was also recommended that experimental dredging be done prior to project formulation. (Spivey-WES)

W71-03321

#### ROGUE RIVER, OREGON.

Corps of Engineers, Washington, D.C. Committee on Tidal Hydraulics.

Printed by U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, March 1970. 18 p, 1 photo.

Descriptors: \*Shoals, Channel improvement, Navigation conditions, Dredging, Oregon.

Identifiers: \*Rogue River, Ore.

Division Engineer, U.S. Army Engineer Division, North Pacific, requested that Committee on Tidal Hydraulics consider the difficulty of maintaining proper navigation dimensions in Rogue River. In addition to shoaling, there is a problem of operating a dredge due to weather and sea conditions. This report presents the pertinent facts bearing on the problems and an analysis along with conclusions and recommendations. (Spivey-WES)

#### THE QUASI-PERMANENT REGIME OF RIVERS AND THE PREDICTION OF FLOODS,

Army Engineer Waterways Experiment Station, Vicksburg, Miss.

G. H. Keulegan, and G. W. Patterson.

Sponsored by the National Bureau of Standards. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper H-69-9, September 1969. 81 p, 14 fig, 34 ref.

## WATER QUANTITY MANAGEMENT AND CONTROL—Field 04

### Control of Water on the Surface—Group 4A

Descriptors: \*River flow, \*River forecasting, Rivers, \*Flood forecasting, \*Discharge measurement.  
Identifiers: \*Maillet transformation, \*Bachet nomograph.

This paper summarizes the early basic knowledge of the quasi-permanent regime of rivers and flood routing. Numerous applications are presented as examples of working methods. (Keulegan-WES)  
W71-03327

**DESIGN OF OVERFLOW ROCKFILL DAMS,**  
Technische Hochschule, Munich (West Germany).  
For primary bibliographic entry see Field 08D.  
W71-03349

**ARKANSAS POWER AND LIGHT CO V ORR (LIABILITY FOR FLOOD DAMAGE CAUSED BY NEGLIGENT FLOOD GATE OPERATION).**  
For primary bibliographic entry see Field 06E.  
W71-03352

**LOUISVILLE AND N RR V VANDIVER (DIVERSION OF RIVER CAUSED BY OBSTRUCTION).**  
For primary bibliographic entry see Field 06E.  
W71-03353

**FOUNDATION PRECOMPRESSION WITH VERTICLE SAND DRAINS,**  
Army Engineer Waterways Experiment Station, Vicksburg, Miss.  
For primary bibliographic entry see Field 08D.  
W71-03356

**PROCEEDINGS MISSISSIPPI WATER RESOURCES CONFERENCE, 1970.**  
Mississippi State Univ., State College. Water Resources Research Inst.

Available from NTIS as PB-196 731, \$3.00 in paper copy, \$0.95 in microfiche. Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ Water Resources Research Institute, 1970, 191 p. OWRR Project A-999-MISS (6).

Descriptors: \*Conferences, \*Water resources, \*Mississippi, \*Water resources research act, Transportation, Port authorities, Hurricanes, Mapping, Floods, Flood damage, Sedimentation, Flood control, Flood plain insurance, Irrigation water, Scour, Channel morphology, Inter-basin transfers, Recreation, Tracers, Water analysis, Water pollution, Bioindicators.

The fifth Mississippi Water Resources Conference was held in Jackson on 14-15 April for the purpose of exchanging information pertaining to water resources. The topics discussed include seaport and transportation development, hurricane damage mapping, hurricane frequency, flood insurance, flood control, alluvial channel morphology, scour, water importation for irrigating the Texas High Plains, recreation, mapping, tracer studies, water analysis, and water pollution indicator organisms. (See also W71-03381 thru W71-03388) (Knapp-USGS)  
W71-03380

**THE ROLE OF TVA RESERVOIRS IN REDUCING FLOOD CRESTS ON THE LOWER OHIO AND MISSISSIPPI RIVERS,**  
Tennessee Valley Authority, Knoxville. Procedures Development Section.  
Russell L. Tucker.

In: Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ Water Resources Research Institute, p 47-73, 1970, 27 p, 10 plate, 1 tab, 8 ref. OWRR Project A-999-MISS (6).

Descriptors: \*Flood control, \*Reservoir operation, \*Tennessee Valley Authority Project, River forecasting, Flood damage, Economics, Tennessee River, Water management (Applied), Ohio River, Mississippi River.

TVA reservoirs have a significant role in reducing flood crests on the lower Ohio and Mississippi Rivers. They have effected crest reductions of over 3 feet. Direct flood damages already prevented total over \$43,000,000, and additional protection is afforded to 6 million acres of productive land protected by downstream levees. Meeting demands for increased effectiveness in flood control requires improved meteorological forecasts and the development of even more effective operating procedures. (See also W71-03380). (Knapp-USGS)  
W71-03382

**CROSS-SPECTRUM ANALYSIS OF GROUND-WATER LEVELS IN AN ESKER,**  
Stockholm Univ. (Sweden). International Meteorological Inst.  
For primary bibliographic entry see Field 02F.  
W71-03394

**ORTHONORMAL FUNCTION TABLES AND THE SEEPAGE OF STEADY RAIN THROUGH SOIL BEDDING,**  
Iowa State Univ., Ames.  
For primary bibliographic entry see Field 02G.  
W71-03441

**EXPLANATION OF PARADOXES IN DUPUIT-FORCHHEIMER SEEPAGE THEORY,**  
Iowa State Univ., Ames. Dept. of Agronomy.  
For primary bibliographic entry see Field 02G.  
W71-03442

**PRELIMINARY REVIEW AND ANALYSIS OF FLOOD CONTROL PROJECT EVALUATION PROCEDURES,**  
INTASA, Menlo Park, Calif.  
For primary bibliographic entry see Field 06F.  
W71-03531

**PARAMETERIZATION OF OBSERVED HYDROGRAPHS,**  
Vermont Univ., Burlington. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 02E.  
W71-03665

**FLOOD REGULATION BY COLUMBIA TREATY PROJECTS,**  
Corps. of Engineers, Portland, Oreg. Water Control Branch.  
Mark L. Nelson, and David M. Rockwood.  
ASCE Proceedings, Journal of the Hydraulics Division, Vol 97, No HY1, Paper 7798, p 143-161, January 1971. 19 p, 12 fig, 1 tab, 9 ref.

Descriptors: \*Flood control, \*Historic flood, \*Columbia River, \*Treaties, \*International Joint Commission, Peak discharge, Dams, Reservoirs, Regulation, Routing, Flood routing, Streamflow forecasting, Water management (Applied), Reservoir operation, Systems analysis.  
Identifiers: \*Columbia River Treaty.

Reservoir regulation by Columbia Treaty Projects, in conjunction with existing U. S. Columbia Treaty Projects, should provide assured control of major floods to reasonably safe levels. A flood control operating plan for the Treaty Projects was developed in accordance with Treaty requirements. This paper describes the flood characteristics of the Columbia River, the principles of flood regulation, and the methods used in developing the flood control operating plan. Results of flood regulation studies for the period 1929-1958, together with the flood of 1894, the maximum

flood of historic record, are presented. (Knapp-USGS)  
W71-03666

**SMALL SAMPLE PROPERTIES OF H AND K-ESTIMATORS OF THE HURST COEFFICIENT h,**

Thomas J. Watson Research Center, Yorktown Heights, N. Y.; and Geological Survey, Washington, D.C.

For primary bibliographic entry see Field 02E.  
W71-03674

**A STOCHASTIC MODEL FOR FLOOD ANALYSIS,**

Colorado State Univ., Fort Collins.  
For primary bibliographic entry see Field 02E.  
W71-03680

**ESTIMATING EXPECTED VALUES FOR MONOTONE SAMPLES,**

Geological Survey, Washington, D.C.; American Univ., Washington, D.C.  
For primary bibliographic entry see Field 07C.  
W71-03689

**SOME EXTENSIONS OF TWO-STREAMS STORAGE MODEL,**

Lancaster Univ., Bailrigg (England).  
A. A. Anis.  
Journal of Hydrology, Vol 11, No 4, p 363-378, November 1970. 16 p, 3 ref.

Descriptors: \*Water storage, \*Reservoir design, \*Streamflow forecasting, Probability, Statistical methods, Mathematical studies, Time series analysis, Markov processes, Stochastic processes, Statistical models.  
Identifiers: \*Reservoir storage forecasting.

Methods are given for calculating reservoir storage probability when two streams of water meet in a joint path but technical difficulties prohibit building a dam on the joint path. The respective inputs are mutually independent, non-seasonal, and without any serial correlation structure. The reservoir is to be managed in such a way as to maintain a given minimum flow below the confluence. The probability of emptiness of the dam before filling completely may also be obtained. This two-stream model is formally equivalent to a single stream model with unit release and a modified input. (Knapp-USGS)  
W71-03699

**THE GENETIC METHOD OF COMPUTATION OF FLOOD CAUSED BY STORM RAINFALLS IN SMALL CATCHMENT AREAS IN THE ABSENCE OF HYDROLOGICAL DATA,**  
Wyzsza Szkoła Rolnicza, Wrocław (Poland).  
For primary bibliographic entry see Field 02A.  
W71-03716

**ESTIMATION OF DESIGN FLOOD DISCHARGES ESPECIALLY FOR RIVER VALLEY PROJECT IN INDIA,**

Ministry of Irrigation and Power (India); and Central Water and Power Commission, New Delhi (India).

For primary bibliographic entry see Field 02E.  
W71-03721

**A UNIFIED NATIONAL PROGRAM FOR MANAGING FLOOD LOSSES,**

Task Force on Federal Flood Control Policy, Washington, D.C.  
For primary bibliographic entry see Field 06E.  
W71-03773

**EXECUTIVE ORDER 11296 (EVALUATION OF FLOOD HAZARD IN FEDERAL ACTIVITIES).**  
For primary bibliographic entry see Field 06E.

## Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4A—Control of Water on the Surface

W71-03778

#### STATUS OF PENDING WATERSHED PROJECTS.

Committee on Agriculture (U. S. House).  
For primary bibliographic entry see Field 06E.  
W71-03790

#### WATERSHED PROJECTS.

Committee on Agriculture (U. S. House).  
For primary bibliographic entry see Field 06E.  
W71-03791

#### ILLINOIS LAWS RELATING TO WATERWAYS, 1969.

Illinois State Dept. of Public Works and Buildings, Springfield.  
For primary bibliographic entry see Field 06E.  
W71-03799

#### WATER FOR ILLINOIS - A PLAN FOR ACTION.

Illinois State Technical Advisory Committee on Water Resources, Springfield.

Springfield, Ill., March 1967. 452 p, 201 fig, 5 map, 2 illus, 152 photo, 83 tab, 3 chart, 95 ref.

Descriptors: \*Water resources development, \*Water supply, \*Water pollution, \*Illinois, State governments, Water resources, Water management (Applied), Water conservation, Water control, Water costs, Water delivery, Water demand, Water policy, Water quality, Water requirements, Water storage, Water treatment, Water utilization, Water loss, Water purification, Watershed management, Federal government, Administrative agencies, Cities, Recreation demand.

This comprehensive study of available Illinois water resources and plans for development defines water resources planning as 'the consideration of alternative uses of the resource to meet future problems and opportunities and to establish priorities for action.' Primary subdivisions of the work are: (1) water resources, (2) water supply and use, (3) pollution and pollution control, (4) land and water management, (5) floods and flood control, (6) navigation, (7) water related recreation, and (8) laws and government. Specific conclusions and recommendations are set forth at the conclusion of each chapter. In the last chapter, the relationships between federal, state, and local government are examined, with special emphasis upon federal assistance for the various projects. The committee concludes that \$1 billion is necessary for the program, as follows: water-related recreation--\$200 million; pollution control--\$350 million; flood control--\$100 million; and water management--\$350 million. The study is replete with graphs, charts, maps and photographs. (Hart-Florida)  
W71-03806

### 4B. Groundwater Management

#### DELINEATION OF GROUNDWATER FLOW SYSTEMS IN NEVADA,

Nevada Univ., Reno. Center for Water Resources Research.

Martin D. Mifflin.

Available from NTIS as PB-196 657, \$3.00 in paper copy, \$0.95 in microfiche. Desert Research Institute Technical Report Series H-W, Publication No 4, Nevada Univ Water Resources Research Center, July 1968. 111 p, 13 fig, 2 plate, 2 tab, 206 ref, append. OWRR Project A-009-NEV (1), A-001-NEV (1), and B-006-NEV (1).

Descriptors: \*Groundwater movement, \*Nevada, \*Aquifers, \*Groundwater basins, Transmissivity, Recharge, Discharge (Water), Water sources, Water yield, Phreatophytes, Surface-groundwater relationships, Model studies, Flow nets, Potential flow, Hydrogeology, Water chemistry, Water temperature, Hydrologic data, Data collections.

Identifiers: Groundwater flow systems (Nev).

Available hydrologic and geologic information was studied using flow system theory in an attempt to delineate groundwater flow systems in Nevada with definition of sink areas, source areas and configuration of flow within the flow system as the primary objective. Source areas and configuration of flow were approximated in most areas. Sink areas have been confidently located for nearly all of the flow systems. Several types of fluid potential measurements are demonstrated to be the optimal methods of delineating groundwater flow systems. Changes in fluid potential in the vertical direction establish source areas, zones of lateral flow, sink areas and boundaries of circulation cells. Groundwater temperature was used to establish apparent depth of circulation. Characteristics of large springs in the carbonate rock province of Nevada, including water chemistry, water temperature, variation in discharge, tritium concentrations and C-14 determinations, have aided flow system delineation. Interbasin flow is closely related to bedrock permeability and availability of moisture for recharge. In nearly every area where interbasin flow has been recognized, there is also relatively permeable bedrock. In most areas of interbasin flow, only limited moisture is available for recharge. (Knapp-USGS)  
W71-03302

#### GROUNDWATER SYMPOSIUM.

For primary bibliographic entry see Field 02F.  
W71-03401

#### GROUNDWATER IN UNCONSOLIDATED SEDIMENTS - RECENT DEVELOPMENTS IN NEW SOUTH WALES,

Water Conservation and Irrigation Commission (Australia).

W. H. Williamson.

In: Proceedings of Groundwater Symposium, New South Wales University, Manly Vale, Australia, August 28-29, 1969; New South Wales University Water Research Laboratory Report No 113, Paper No 1, p 1-12, April 1970. 12 p, 1 fig, 5 ref.

Descriptors: \*Water resources development, \*Hydrogeology, \*Alluvium, Surface-groundwater relationships, Irrigation water, Water yield, Reviews, Surveys.

Identifiers: \*Australia, \*New South Wales.

There has been a marked increase in the development of the groundwater resources of unconsolidated sediments in New South Wales, Australia in recent years. The causative factors, including the discovery of hitherto unknown resources and the trend to large diameter bores, are reviewed. The acreage irrigated with groundwater has expanded rapidly, particularly since about 1964. In 1967-68, about 97,000 acres were irrigated, an increase of about 12% over irrigation in 1966-67. (See also W71-03401) (Knapp-USGS)  
W71-03402

#### SEISMIC REFRACTION AND ELECTRICAL RESISTIVITY: TOOLS IN GROUNDWATER EXPLORATION,

Iowa State Univ., Ames. Dept. of Earth Science.

For primary bibliographic entry see Field 07B.  
W71-03439

#### RELATIONSHIP BETWEEN HORIZONTAL STRAIN NEAR A WELL AND REVERSE WATER LEVEL FLUCTUATION,

Geological Survey, Washington, D.C.

For primary bibliographic entry see Field 02F.  
W71-03686

#### MULTIPLE GRAVITY WELLS UNDER TRANSIENT STATES OF FLOW,

North Carolina State Univ., Raleigh.

For primary bibliographic entry see Field 02E.  
W71-03687

#### ROTARIES TO PLAY BIG ROLE IN FUTURE ROCK - DRILLING METHODS,

Christensen Diamond Products Co., Salt Lake City, Utah.

For primary bibliographic entry see Field 08A.  
W71-03830

#### DRILLING-MUD LUBRICITY,

National Lead Co., Houston, Tex. Baroid Div.

T. C. Mondshine.

Oil and Gas Journal, Vol 68, No 49, p 70-77, December 7, 1970. 5 tab, 4 ref.

Descriptors: \*Drilling fluid, \*Drilling, Oil industry, Mud.

Identifiers: \*Mud lubricity tester, \*Lubricity coefficient, Drill string lubrication, Drilling mud additives.

Unless the drilling fluid provides adequate lubrication, considerable friction exists when a drill string is rotated against a borehole or walls of a cased hole. These frictional forces are especially high in directional or crooked holes, and may result in excessive torque when the string is rotated, or in excessive drag when the drill string is pulled from the hole. Many drilling mud additives are used to reduce torque and drag. The overall performance of many of these materials as drilling mud lubricants is doubtful. Laboratory studies were initiated to investigate drilling mud lubricity which primarily involves the rubbing of drill pipe and bit against the borehole during rotation and tripping. A mud lubricity tester simulates drill-pipe rotation and load and measures frictional force. The step-by-step procedure of testing the lubricity of drilling mud is listed. In order to simulate various conditions of drillpipe speed and load, tests were conducted at loads of 240, 480, and 720 psi, and at 60, 120, 240, and 360 rpm. The force needed to initiate movement (static) was measured also at these loads. The coefficient of friction was measured at each of these conditions using water and a typical drilling mud field sample. The results are given in tabular data. (Campbell-NWWA)  
W71-03831

#### FISHING IS MORE ART THAN SCIENCE,

Forest Oil Corp., Midland, Tex.

E. W. Porter.

Oil and Gas Journal, Vol 68, No 38, p 95-96, September 21, 1970. 1 fig.

Descriptors: \*Drilling, \*Drilling equipment, Oil industry.

Identifiers: \*Fishing, \*Mechanical equipment failure, Down-hole problems, Human error, Collar inspection, Service factor, Aluminum drill pipe, Slipping conditions, Excessive torque, Overshoots, Grapples.

The art of fishing, broadly defined as the attempted recovery of any item from a well which prohibits the continued progress of the desired operation is undoubtedly only very little younger than the art of drilling. Drilling has progressed to a science, but fishing remains as it started, an art. The causes of fishing jobs fall into 3 main categories: mechanical failure of equipment, downhole problems related to hole conditions, and human errors. Each cause can be minimized, but it is important to realize that economics and time must always be considered. The normal practice in safeguarding against mechanical failure is limited to the inspection of drill pipe and collars. The problems in hole condition which create fishing jobs relate primarily to unstable formations. These are generally controlled with one or more of the many mud systems available. In evaluation of preventive measures to provide hole stability, the time factor must be considered. Human error continues to remain a major factor in causing fishing jobs. The best chance of avoiding a fishing job lies in good job planning based on the best available data; in the ability to anticipate problems; and in good communications. (Campbell-NWWA)  
W71-03832

## Groundwater Management—Group 4B

**KEYS TO MILLING, WASHOVER OPERATIONS,**

Signal Oil and Gas Co., Midland, Tex.

B. Bernard Lankford, Jr.

Oil and Gas Journal, Vol 68, No 38, p 97-104, September 1970. 5 fig, 1 tab.

Descriptors: \*Drilling, \*Drilling equipment, Oil industry, Drilling fluids.

Identifiers: \*Fishing, Method of sticking, Washpipe length and size, Rotary shoe, Open-hole washover, Washover inside casing, Milling.

There are many methods of retrieving 'junk' from the hole and each one has its own special application. In almost all cases, a fishing expert should be on location to supervise the operations. The details of the operation which are handled by the fishing expert are not discussed but some of the basic decisions which must be made before fishing is begun is considered. Washover operations are used to retrieve stuck drill pipe on drill collars, and in some instances casing. Washing over consists of rotating a larger pipe over the smaller stuck pipe and cutting away the material causing the sticking. Milling operations are used when the 'fish' cannot be retrieved. Milling is described as drilling up the fish by the oil industry. Before washover operations are begun several factors must be considered, i.e., (1) drilling fluid condition, (2) method and depth of sticking, (3) washpipe size and length and (4) type of rotary shoe. (Campbell-NWWA)

W71-03833

**CONSIDER LOST CIRCULATION IN WELL PLANNING, RIG SELECTION,**

Mobil Oil Corp., New Orleans, La.

J. W. Kerr.

Oil and Gas Journal, Vol 68, No 38, p 92-94, September 1970. 2 fig.

Descriptors: \*Drilling, \*Rotary drilling, Drilling equipment, Oil industry.

Identifiers: \*Lost circulation, \*Rig selection, \*Well planning, Formation pore pressures, Fracture gradients, Mud loss, Lost circulation recognition.

Lost circulation continues to be a serious drilling problem. Sufficient occurrences can double the cost of an oil well. Improved drilling technology has had a significant impact on the problem. The ability to calculate formation pore pressures and fracture gradients has done much to reduce the frequency of lost circulation problems. Using the minimum mud weight required to control the formation pore pressure will not only speed drilling but will also result in less mud loss. Lost circulation can be classified as: (1) seepage loss to highly permeable, uncemented, shallow sands, gravel or shell beds, or vugular limestone, (2) sudden complete loss to cavernous formation and (3) partial or complete loss to natural or induces fractures. This is the most troublesome type. (Campbell-NWWA)

W71-03834

**PREVENTING FILAMENTOUS SCALE IN WATER WELLS,**

Sayreville Water Works, N.J.

For primary bibliographic entry see Field 08G.

W71-03835

**DESIGN AND RATING OF WELLS AND WELL FIELDS,**

Michigan State Geological Survey, Lansing, Dept. of Conservation.

L. M. Miller.

American Water Works Association Journal, Vol 49, No 4, p 439-449, April 1957.

Descriptors: \*Water works, \*Water supply, Water wells, Municipal wells, Well spacing, Groundwater.

Identifiers: Groundwater development, Geological conditions, Flow characteristics, Coefficient of permeability, Well losses.

The article reviews the technical field design problems of municipal water wells. The purpose of

the paper is to promote interest and understanding of sound technical approaches to field design problems of wells. Complex relationships are simplified and cover topics such as the relationship of spheres to pores sizes, coefficient of permeability, and interpreting test data. The presentation is applicable to the general public. (Campbell-NWWA)

W71-03836

**PRODUCTION ANALYSIS OF ARTESIAN WELLS,**

Purdue Univ., Lafayette, Ind.

A. L. Simon.

American Water Works Association Journal, Vol 52, No 11, p 1438-1446, November 1960.

Descriptors: \*Artesian wells, \*Water wells, Specific capacity, Groundwater, Darcy's Law, \*Head loss, Hydrogen sulphide, Carbon dioxide.

Identifiers: Discharge-drawdown analysis, Hungary, Interconnected aquifers, Juhasz Equation.

Water and energy waste can be eliminated by proper investigation. A conscious appreciation of the following methods of investigation would considerably improve the present waste, (1) discharge-drawdown analysis, (2) interconnecting aquifer hydraulics, (3) determination of characteristics for each aquifer by rheometering, (4) role of thermal dilation and effect of temperature on head, (5) problems of corrosion caused by hydrogen sulphide and carbon dioxide. (Campbell-NWWA)

W71-03837

**PERFORMANCE OF ALLOYS AGAINST EROSION - CORROSION ATTACK,**

Stainless Foundry and Engineering, Inc., Milwaukee, Wis.

For primary bibliographic entry see Field 08G.

W71-03838

**SECOND CORROSION STUDY OF PIPE EXPOSED TO DOMESTIC WATERS,**

For primary bibliographic entry see Field 08G.

W71-03839

**RELATION BETWEEN AQUIFER PERMEABILITY AND IMPROVEMENT ACHIEVED BY WELL STIMULATION,**

Louis Koenig-Research, San Antonio, Tex.

Louis Koenig.

American Water Works Association Journal, Vol 53, No 5, p 652-670, May 1961. 22 ref.

Descriptors: \*Water wells, \*Water yield improvement, Specific capacity, Coefficient of permeability, Oil industry.

Identifiers: \*Permeation factor, Equilibrium radial flow, Fracturing, \*Improvement ratio, Poiseuille Law.

The article states that variation in permeability of aquifers has certain bearing on improvement achieved by well stimulation. The relation is defined in numerical terms and suggests that improvement ratios achieved by every type of treatment decrease with increases in permeation factor. Methods are discussed which offer increases in permeability of various types of well stimulation. Some of the techniques used in the petroleum industry can be adapted to the groundwater industry. (Campbell-NWWA)

W71-03840

**CLEANING METHODS FOR DEEP WELLS AND PUMPS,**

Board of Water and Light, Lansing, Mich.

Claud R. Erickson.

American Water Works Association Journal, Vol 53, No 2, p 155-162, February 1961.

Descriptors: \*Water wells, \*Municipal wells, Pumps, Pump testing, Well screens, Corrosion.

Identifiers: \*Deep well cleaning, \*Stimulation, Redevelopment, Inefficient pump operation, Scale deposits, Static water level.

Two factors which are extremely important to the efficient operation of a well are: (1) stimulation, or redevelopment of the well when it has declined in productivity, and (2) the cleaning and, if necessary, reconditioning of the pump. The article assumes four basic causes of declines in well production: (1) lowering of the static water level, (2) inefficient pump operation caused by worn, corroded, or plugged parts, (3) deposits of scale, corrosion products, and microorganism growths in the well screen area and on the face of the producing formation, and (4) fouling of the well screen area by mud, sand and silt. Reconditioning of the well and pump can aid in recovering lost production if the decline is due to any of the last three causes. (Campbell-NWWA)

W71-03841

**DEVELOPMENT OF REVERSE-ROTARY WELLS,**

Winter-Weiss Co., Denver, Colo; and Lauman (C.W.), Bethpage, N.Y.

For primary bibliographic entry see Field 08A.

W71-03844

**DEVELOPMENT OF WELLS WITH CABLE TOOLS,**

Bucyrus-Erie Co., South Milwaukee, Wis.

For primary bibliographic entry see Field 08A.

W71-03845

**REVERT CUTS COSTS AND MAKES BETTER WELLS,**

Universal Oil Products Co., St. Paul, Minn. Johnson Div.

For primary bibliographic entry see Field 08A.

W71-03846

**REVERSE ROTARY WELL CONSTRUCTION,**

Illinois State Water Survey, Urbana.

For primary bibliographic entry see Field 08A.

W71-03847

**CEMENTING WATER WELLS,**

Halliburton Oil Well Cement Co., Houston, Tex.

For primary bibliographic entry see Field 08A.

W71-03848

**SURVEY AND ANALYSIS OF WELL STIMULATION PERFORMANCE,**

Louis Koenig-Research, San Antonio, Tex.

Louis Koenig.

American Water Works Association Journal, Vol 52, No 3, p 333-350, March 1960.

Descriptors: \*Water wells, \*Water yield improvement, Oil industry, Recharge.

Identifiers: \*Well stimulation, Specific capacity improvement, Water well hydraulics, Oil well hydraulics.

The results of a study of 870 water well stimulation cases in 141 counties of 24 states are discussed. For all types of treatment in all types of formations median ratio indicates 97% improvement over specific capacity immediately before treatment and 20% improvement over original production of water well. Treatment failures amounted to 11% with success being greater in consolidated formations than in unconsolidated formation. The study is based on the assumption that a close similarity exists between the technology of crude-oil production and the technology of groundwater production. (Campbell-NWWA)

W71-03849

**DRILLING POROSITY LOG PROVES ACCURATE,**

J. L. Kennedy.

## Field 04—WATER QUANTITY MANAGEMENT AND CONTROL

### Group 4B—Groundwater Management

Oil and Gas Journal, Vol 68, No 34, p 53-55, August 24, 1970. 2 fig.

Descriptors: Logging (Recording), Drilling, Porosity, Boreholes, Drill holes, Geologic formations, Radioactive logging.

Identifiers: Drilling data, Drilling costs, Optimum drilling conditions, Computer use, Rock properties, Bit performance, Pore pressure, Gulf Coast formations, Bulk density logging, Pseudodensity.

Continued refinement in the use of drilling data has been a big factor in keeping oil drilling costs within reasonable limits as materials and labor expense continue to climb. One big hurdle was developing the ability to collect this information during drilling, and analyze it thoroughly enough to be of immediate benefit. Drilling data can be gathered on a given bit run and analyzed in time to determine the optimum drilling conditions to be used on the succeeding bit run. The use of computers is the basis for this advancement. It has been concluded that drilling response is related to the shear and compressive strength of rocks, and these properties are used to indicate porosity in several logging techniques. Thus, rock properties used initially for predicting bit performance and drilling optimization are now used for formation evaluation. One of the resultant new logs is the drilling porosity log (DPL). It interprets drilling data that are related to formation properties, providing an early indication of formation type and porosity. (Campbell-NWWA)

W71-03850

### 4C. Effects on Water of Man's Non-Water Activities

#### RATES OF WATER INFILTRATION RESULTING FROM APPLICATIONS OF DAIRY MANURE,

Cornell Univ., Ithaca, N.Y. Dept. of Agronomy. P. J. Zwerman, A. B. Drielsma, G. D. Jones, S. D. Klausner, and D. Ellis.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 263-270. 6 tab, 17 ref.

Descriptors: \*Farm wastes, \*Cattle, \*Infiltration, Time, Corn, Alfalfa, Wheat, Rotations, Rainfall simulators, Rates of application, Fertilizers, Surface runoff, Rainfall.

Identifiers: \*Dairy cattle, Intensity, Plots, Mass infiltration.

Sixty randomly selected plot locations were subject to infiltration tests with a rainfall simulator. Three successive tests of one half hour each were applied to the same plot. These results represent the effects of fourteen years of past management on seed beds prepared for corn. The rainfall rate was two and one half inches per hour. A two-by-two factorial and a two-by-four factorial experimental design were utilized. The two-by-two comparisons involved six tons of dairy manure plowed down versus no manure on continuous corn for grain at two rates of mineral fertilization. Manure increased infiltration by 27 percent, heavy mineral fertilization without manure on the last run resulted in a 60 percent decrease in infiltration as compared to manure with moderate mineral fertilization. The two-by-four factorial study again involved six tons of manure plowed down versus no manure on four rotations: (1) continuous corn for grain, (2) corn-oats-alfalfa-alfalfa, (3) corn-corn-oats-alfalfa-alfalfa, and (4) wheat-alfalfa-alfalfa-alfalfa-alfalfa. Manure did not significantly increase rates of infiltration. All rates of fertilization were very moderate. Only rotation No. 4 gave a significant 16 percent increase in rate of infiltration. (See also W71-03542) (White-Iowa State) W71-03554

### 4D. Watershed Protection

STRATIGRAPHY, SEDIMENTOLOGY, AND MOISTURE CONTENTS IN A SMALL LOESS WATERSHED IN TAMA COUNTY, IOWA, Iowa State Univ., Ames. Dept. of Agronomy. For primary bibliographic entry see Field 02G. W71-03440

VEGETATION AND WATERSHED SHAPE, Cornell Aeronautical Lab., Buffalo, N.Y. For primary bibliographic entry see Field 02J. W71-03692

#### WATERSHED PROJECTS.

Committee on Agriculture (U. S. House). Subcommittee on Conservation and Credit. For primary bibliographic entry see Field 06E. W71-03787

#### STATUS OF PENDING WATERSHED PROJECTS.

Committee on Agriculture (U. S. House). For primary bibliographic entry see Field 06E. W71-03790

#### WATERSHED PROJECTS.

Committee on Agriculture (U. S. House). For primary bibliographic entry see Field 06E. W71-03791

### 05. WATER QUALITY MANAGEMENT AND PROTECTION

#### 5A. Identification of Pollutants

##### ANALYSIS OF SOLUTIONS FOR SURFACE ACTIVE AGENTS,

Kentucky Water Resources Inst., Lexington. Kentucky Univ., Lexington. Dept. of Chemistry. For primary bibliographic entry see Field 02K. W71-03305

##### DEVICE FOR FIELD DETERMINATION OF HEAVY METALS IN NATURAL WATERS,

Illinois Univ., Urbana. Water Resources Center. Robert E. Van Atta.

Available from NTIS as PB-196 665, \$3.00 in paper copy, \$0.95 in microfiche. Final Report, Illinois Water Resources Center, Urbana, WRC Research Report No 35, December 1970. 28 p, 6 tab, 15 fig. OWRR Project A-032-III (1).

Descriptors: Trace elements, Water analysis, Water chemistry, Electrolytes, Streams, Electrodes, Polarographic analysis, Analytical techniques, \*Pollutant identification, \*Heavy metals, Instrumentation, Ions, Copper, Chromium. Identifiers: Cadmium, Lead, Nickel, Zinc.

The objective was the development and testing of a simple, portable, self-contained device suitable for in situ analysis of natural waters for certain trace metals. The trace metals which were of primary interest were copper, lead, cadmium, nickel, chromium and zinc. Two models of the analyzer were built during the course of this experiment. The first model utilized a rotating platinum electrode in sulfosalicylic acid electrolyte. This was abandoned due to the inconsistent quality of high sensitivity results in the field and the interference of the sulfosalicylic acid medium with analysis of lead and iron ions. The second model used a dropping mercury electrode (DME) in the same electrolytic medium. The medium was discarded due to the interference with lead and iron, but the DME was

retained with tri-sodium citrate as the medium since this allows analysis of lead, cadmium, zinc and iron. Details of the construction and field operation of the kit are explained in full. Field sampling techniques are also discussed. The operation of the device is relatively simple and the cost of construction of the initial model was less than \$400. The design of the instrument allows the possibility of future development and adaptations. At present, however, the determination of metals is limited to only four ions. The use of mercury makes careful disposal of waste materials necessary. The results have not been compared with the results from known different tests with known reliability. W71-03311

A PRELIMINARY REPORT ON RAPID BIOLOGICAL INFORMATION SYSTEMS FOR WATER POLLUTION CONTROL, Virginia Polytechnic Inst., Blacksburg, Va. For primary bibliographic entry see Field 05C. W71-03367

INTERFERENCE STUDIES IN THE DETERMINATION OF SODIUM, POTASSIUM, CALCIUM, AND MAGNESIUM IN NATURAL WATERS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY, Agricultural Research Service, Oxford, Miss., Sedimentation Lab.

For primary bibliographic entry see Field 02K. W71-03386

RELATIONSHIP BETWEEN POLLUTION INDICATOR ORGANISMS AND THE SALINITY OF MISSISSIPPI'S ESTUARINE WATERS, Gulf Coast Research Lab., Ocean Springs, Miss. D. W. Cook, and G. W. Childers.

In: Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ Water Resources Research Institute, p 181-191, 1970. 11 p, 6 fig, 6 ref. OWRR Project A-999-MISS (6).

Descriptors: \*Estuaries, \*Mississippi, \*Coliforms, \*Salinity, Water pollution sources, Bioindicators, Oysters, Wetlands, Commercial fishing, Sport fishing, Water pollution effects. Identifiers: \*Mississippi Sound.

In general, there is an inverse relationship between the median coliform MPN and the median salinity of the waters of the Mississippi Sound and nearby estuaries. There was, however, considerable variation in the individual coliform MPN counts obtained at all stations. The coliform MPN - salinity relationships in the major bay areas of the Sound were found to be different. These differences are attributed to the different natures and locations of the sources of the indicator organisms in the areas and to the variations in the deep water channels in the area. (See also W71-03380). (Knapp-USGS) W71-03387

SEASONAL VARIATION OF THE SOLUTE CONTENT AND THE Sr-87/Sr-86 RATIO OF THE OLENTANGY AND SCIO TO RIVERS AT COLUMBUS, OHIO,

Ohio State Univ., Columbus, Ohio. Dept. of Geology, and Ohio State Univ., Columbus, Ohio. Water Resources Center.

For primary bibliographic entry see Field 02K. W71-03390

A CONTROLLED DEPTH, VOLUMETRIC BOTTOM SAMPLER, Herbert W. Jackson.

The Progressive Fish Culturist, Vol 33, No 2, p 113-115, April 1970. 4 fig, 14 plates, 3 ref.

Descriptors: \*Sampling, \*Benthos, \*Estuarine environment, Limnology, Volume, Shallow water, Potamology, Safety, Mechanical equipment,

## Identification of Pollutants—Group 5A

Dredging, Bottom sediments, Marine animals, Aquatic environment, Ecology, Mudflats, \*Pollutant identification, \*Littoral.  
Identifiers: Quantitative sampling, Infauna, Pollution ecology.

Basic plans are presented for a modification of the Petersen dredge principle for use by hand in wadeable waters, freshwater or marine. Extension handles could be rigged for use from a boat for use in waters up to ten or twelve feet in depth, similar to oyster tongs. Both area and depth sampled can be controlled by design, making volumetric sampling feasible if desired. Tips of jaws travel at constant depth. Ample vents covered with fine screening permit escape of water without loss of organisms. Closure of side gap when dredge is open eliminates loss of organisms via open ends during closure, also in running water. Depth regulator prevents sinking in soft bottoms, strong construction permits use in sands and gravels with up to three or four inch stones. Manipulation and power of hand closure reduces dry hauls from sticks or pebbles jammed between jaws. Handles promote safety from broken glass and other sharp objects in polluted areas. They also permit use in deeper waters than can be conveniently sampled with Surber type hand sampler, or sampling in inclement weather such as through ice. Sample can be taken quickly, dumped into tub, and slurried or handsorted as desired. Construction of high strength thin steel would reduce weight; stainless steel would eliminate corrosion.

W71-03449

**CHANGES IN THE BLOOD OF BROOK TROUT (SALVELINUS FONTINALIS) AFTER SHORT-TERM AND LONG-TERM EXPOSURE TO COPPER,**  
National Water Quality Lab., Duluth, Minn.  
For primary bibliographic entry see Field 05C.  
W71-03450

**CULTURE OF LAKE HERRING IN THE LABORATORY,**  
National Water Quality Lab., Duluth, Minn.  
John G. Hale.  
The Progressive Fish-Culturist, Vol 32, No 4, p 217-221, 1970. 4 tab, 7 ref. FWQA Program 18050 WAD 10/70.

Descriptors: Life history studies, Fish diets, Bioassay methods, Fish growth, Minnesota, Herrings, \*Cisco.  
Identifiers: Fish Culture, Duluth (Minnesota), Coregonus artedii.

Lake herring, Coregonus artedii, eggs were collected from the field, incubated, hatched, and the larvae cultured in the laboratory on two successive years. Incubation temperatures averaged 4.2C the first year and 3.9C the second. The larvae were raised at 5.2C. A diet of live brine shrimp (automatically dispensed) produced the largest post larval fish and the lowest mortality during a 30-day trial of five diets. Live brine shrimp (automatically dispensed), smaller tanks, and daily treatment of larvae with malachite green improved survival the second year of testing. Growth rate in the laboratory appeared to be slower than the calculated growth rate of lake herring collected from Lake Superior in the Duluth area in August during their second year of life.

W71-03451

**AN EVALUATION OF THE INFRA-RED THERMOMETER AS AN AIRBORNE INDICATOR OF SURFACE WATER TEMPERATURES,**  
Department of Transport, Toronto (Ontario). Meteorological Branch.  
For primary bibliographic entry see Field 07B.  
W71-03466

**FATTY ACID CONTENT AS A MEASURE OF THE ODOUR POTENTIAL OF STORED LIQUID POULTRY MANURE,**  
Guelph Univ. (Ontario). Dept. of Microbiology.  
R. G. Bell.

Poultry Science, Vol 49, No 4, p 1126-1129, July 1970. 4 fig, 7 ref. Ontario Dept of Food and Agr No 695-04 Research Council of Canada No A5730.

Descriptors: \*Poultry, \*Legislation, \*Odor, Farm wastes, Liquid wastes, Gas chromatography.  
Identifiers: Fatty acid content, Odor potential.

An attempt was made to find a correlation between odour and the concentration of volatile fatty acids in stored liquid poultry manure. Using both gas chromatographic and column partition chromatographic analysis procedures a relationship between the odour and the fatty acid content of stored liquid poultry manure was observed. A total fatty acid content of 0.1% is suggested as a maximum level to be deemed acceptable for new installations and 0.2% as a minimum level for the initiation of prosecution which may be contemplated for existing facilities. (Christenbury-Iowa State)

W71-03535

**URINARY CREATININE AS AN INDEX COMPOUND FOR ESTIMATING RATE OF EXCRETION OF STEROIDS IN THE DOMESTIC SOW,**  
Purdue Univ., Lafayette, Ind.

R. E. Erb, S. A. Tillson, G. D. Hodgen, and E. D. Plotka.

Journal Paper No 3644, Purdue University Agricultural Experiment Station. Journal of Animal Science, Vol 30, No 1, p 79-85, January 1970. 5 tab, 20 ref.

Descriptors: Farm wastes, Urine, Hogs, Livestock, Animal physiology.

Identifiers: \*Steroids, \*Creatinine, Index compound.

During two experiments urine was collected from 36 yearling sows to estimate rate-of-excretion of creatinine and to evaluate its use as an index compound. Excretion rate averaged 205 mg/hr. and 1.35 mg/hr./kg live weight for Experiment I as compared to 201 mg/hr. and 1.38 mg/hr./kg live weight for Experiment II. Measurement of urine volume for 48-hr. allows estimation of creatinine excretion rate of sows with coefficients of variability of 7-8%. In comparison, the coefficients of variability were 18 and 13%, respectively, for 12-hr. and 24-hr. periods. These experiments show that the ratio, microgram steroid per mg urinary creatinine is an accurate method for expressing rate of excretion of steroids in urine. (Christenbury-Iowa State)

W71-03538

#### INTRODUCTION,

Michigan State Univ., East Lansing. Dept. of Poultry Science.

H. C. Zindel, and C. J. Flegal.

In: Research Report 117, Farm Science, MSU Agricultural Experiment Station, July 1970, p 4-7.

Descriptors: \*Farm wastes, \*Poultry, Odor, Water pollution, Air pollution, Soil contamination, Technology, Nitrates, Nitrites, Disease, Insects, Treatment, Disposal, Standards, Land use.

Identifiers: \*Environmental quality, \*Confinement production, Animal management, Facility design.

The introductory remarks explain that agriculture-related pollution is but one part of a large national problem; so it must be considered together with municipal, industrial, marine and all other types of pollution in developing an integrated plan for improving the quality of our environment. The volume of livestock wastes produced is a function of the degree concentration and the size of individual production units. Animal wastes are of concern in water, air, and soil pollution. Examples of the increasing numbers of livestock and poultry being produced are given. New and improved technology is needed to handle the wastes from

these animals. Problems discussed concerning pollution are: disease, odor, soil contamination, and insects. Four areas of emphasis are given that encompass the elements of a program for controlling animal wastes. (See also W71-03555) (White-Iowa State)

W71-03556

**DISTRIBUTION OF ARSENIC FROM POULTRY LITTER IN BROILER CHICKENS, SOIL, AND CROPS,**

Salsbury Labs., Charles City, Iowa. Dept. of Biochemistry.

Joseph L. Morrison.

Journal of Agricultural and Food Chemistry, Vol 17, p 1288-1290, November 1969. 5 tab, 27 ref.

Descriptors: \*Arsenic, \*Farm wastes, \*Poultry, Soil, Crops, Assay, Alfalfa, Clovers, Correlation analysis, Groundwater, Pesticides.

Identifiers: \*Poultry litter, \*Arsenical feed additives, Hydrolized feather meal, Poultry tissue, Roxarsone.

The effect of the presence of organoarsenicals from feed additives in poultry house litter was investigated with respect to the distribution of arsenic in chickens raised on this litter, to the distribution of arsenic in soil fertilized with this litter, and to the distribution of arsenic in crops raised on soil fertilized with this type litter. Although measurable amounts of arsenic (15-30 ppm) were found in the litter, the arsenic content of soil and crops was unaffected by the use of poultry litter as fertilizer. Similarly, the arsenic content of birds was unaffected when raised on this type litter. (White-Iowa State)

W71-03565

**SURFACE RUNOFF AND NUTRIENT LOSSES OF FENNIMORE WATERSHEDS,**

Wisconsin Univ., Madison. Dept. of Agricultural Engineering. State of Wisconsin.

S. A. Witzel, Neal E. Minshall, M. Starr Nichols, and John Wilke.

Transactions of the ASAE, Vol 12, No 3, 1969, p 338-341. 4 tab, 3 fig, 5 ref.

Descriptors: \*Surface runoff, \*Nutrients, Fertilizers, Farm wastes, Nitrogen, Phosphorus, Potassium, Wisconsin, Agricultural watersheds, Discharge, Soils, Topography, Geology, Cover crops, Weirs, Precipitation, Snow.

Identifiers: \*Runoff sampler, Fennimore, Wisconsin.

The paper describes the soils, geology, topographic features and cover of a 330 acre watershed near Fennimore, Wisconsin. The watershed was subdivided and weirs were placed with semi-automatic runoff samplers to sample winter runoff water. The amount of commercial fertilizer as well as manure that was applied was determined. The runoff samples were analyzed and the amount of nutrients lost was calculated from the weir calibration. The amount of runoff during the winter of 1967 was about twice the 29 year average. The nutrients lost in surface runoff were much greater than those in the base flow of southwestern Wisconsin streams. In a year of average runoff, assuming nutrient losses directly proportional to runoff, the losses would be 2 lb. nitrogen, 0.6 lb. phosphorus and 4 lb. potassium per acre. (White-Iowa State)

W71-03571

**NITRATE AND OTHER WATER POLLUTANTS UNDER FIELDS AND FEEDLOTS,**

Agricultural Research Service, Fort Collins, Colo.

Soil and Water Conservation Research Div.

B. A. Stewart, F. G. Viets, Jr., G. L. Hutchinson, and W. D. Kemper.

Environmental Science and Technology, Vol 1, No 9, p 736-739, September 1967. 2 fig, 1 tab, 1 ref.

Descriptors: \*Nitrogen, \*Nitrates, \*Farm wastes, Groundwater, Water pollution, Water table, Soils,

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5A—Identification of Pollutants

Irrigation, Fertilizers, Precipitation, Corn, Hydraulic conductivity, Carbon, Oxidation-reduction potential, Alfalfa, Ammonium compounds, Colorado.

Identifiers: Feedlots, Soil cores, Groundwater pollution, South Platte.

Agriculture's effect on nitrate pollution of groundwater was investigated in the South Platte valley of Colorado. The valley is intensively farmed and contains many concentrated livestock feeding operations. A water table, generally between 3 and 20 meters below the surface, underlies much of the area. The average total nitrate-nitrogen to a depth of 6.7 meters in the profiles for the various kinds of land use was: alfalfa (13 cores), 70; native grassland (17 cores), 81; cultivated dry land (21 cores), 233; irrigated fields not in alfalfa (28 cores), 452; and feedlots (47 cores), 1282 kg. per hectare. Groundwater samples often contained high concentrations of nitrate, and those obtained beneath feedlots contained ammonium-nitrogen and organic carbon. (White-Iowa State)

W71-03575

#### SWINE WASTE MANAGEMENT - PROPERTIES OF SWINE WASTES,

Illinois Univ., Urbana. Dept. of Agricultural Engineering.

Arthur J. Muehling.

Cooperative Extension Service, University of Illinois at Urbana-Champaign, August 1969. 2 p. AEng-876.

Descriptors: \*Farm wastes, \*Physical properties, \*Chemical properties, \*Biological properties, Hogs, Antibiotics, Nitrogen, Potash, Biochemical oxygen demand, Chemical oxygen demand, Nutrients, Animal physiology, Biological treatment.

Identifiers: \*Daily production, \*Fertilizer value, Phosphoric acid, Population equivalent, Feed ration, Solids.

An understanding of the properties of swine wastes is necessary to develop an adequate system of waste management. The properties of swine wastes as classified by this fact sheet are physical, chemical, and biological. The physical and chemical properties may be affected by the physiology of the animal, the feed ration, and the environment. The quality of feed influences the amount the hogs will eat and the chemical composition of the wastes. The physical properties of daily production and amount of solids are listed by this fact sheet. The fertilizer value of swine manure is shown and the amounts required to obtain certain pounds per acre of nitrogen, potash, and phosphoric acid are told. Average values for BOD, COD and population equivalent are listed as biological properties of swine manure. (White-Iowa State)

W71-03588

#### PHOSPHORUS CONTENT IN UNCONSOLIDATED SEDIMENTS FROM SOUTHERN LAKE MICHIGAN,

Illinois State Geological Survey, Urbana.

John A. Schleicher, and John K. Kuhn.

Illinois Geological Survey Environmental Geology Notes No 39, November 1970. 15 p, 12 fig, 4 tab, 5 ref.

Descriptors: \*Phosphorus, \*Bottom sediments, \*Lake Michigan, Pollutant identification, Path of pollutants, Water pollution sources, Sampling, Chemical analysis, X-ray fluorescence, X-ray spectroscopy.

Identifiers: Southern Lake Michigan.

177 samples from unconsolidated sediments on the bottom of Lake Michigan were analyzed by X-ray fluorescence spectrophotography for total phosphorus content; the samples, from varying depths, were taken from 56 locations. Statistical analyses of the results show that although the concentrations of phosphorus are uniformly rather low, correlations can be shown between the phosphorus content and,

notably, the amounts of arsenic, iron, and organic carbon. (Knapp-USGS)  
W71-03703

#### WATER POLLUTION IN LAKE MICHIGAN BY TRACE ELEMENTS FROM POLLUTION AEROSOL FALLOUT,

Michigan Univ., Ann Arbor.

John W. Winchester, and Gordon D. Nifong. Contribution 161, Dept of Meteorology and Oceanography, (1970). 29 p, 14 tab, 1 fig, 22 ref. USAEC Contract AT (11-1)-1705.

Descriptors: \*Lake Michigan, \*Water pollution sources, \*Water pollution, \*Air pollution, \*Air pollution effects, \*Water quality, Urbanization, Cities.

Identifiers: \*Metropolitan areas, \*Chicago metropolitan area, \*Milwaukee metropolitan area, \*Northwestern Indiana metropolitan area, Urban environment.

Certain trace elements which are strongly associated with air pollution sources in the Lake Michigan basin may be contributing significantly to lake water pollution by an atmospheric fallout route. A partial inventory of air pollution emissions for 30 trace elements is presented for the Chicago, Milwaukee, and northwest Indiana metropolitan areas, based on available published information, and compared with natural and pollution stream trace element inputs. Evidence indicates that the atmosphere may be the major source of Zn in Lake Michigan, and atmospheric inputs of Cu and Ni are also considerable. Moreover, the evidence suggests that air pollution probably exceeds expected unpolluted stream inputs for many additional elements in Lake Michigan, highlighting the need for more comprehensive chemical data to quantify the evaluation. (Davis-Chicago)

W71-03764

#### DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT VOLUME I TEST-CASE STUDIES,

Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

G. A. Lutz, S. B. Gross, J. B. Boatman, P. J. Moore, and R. L. Darby. Available from NTIS as PB-194 398, \$3.00 in paper copy, \$0.95 in microfiche. Final Report, July 1967. 146 p. PHS Contract PH-86-66-165.

Identifiers: \*Hazardous materials, Evaluation, \*Pollution, Hazardous materials, \*Public health, Human ecology, Toxic diseases, Mercury, Vanadium, Nickel, Fluorohydrocarbons, Paper industry, Pulp mills, Dosimetry, \*Environmental health hazards.

The report is an initial effort in the development of a program that allows the Public Health Service to maintain an active overview of chemical contaminants that are now, or are likely to be, present in the environment. To illustrate the methods of applying the approach, as well as to develop the base for considering eventually all possible hazards, five specific contaminant classes are selected for individual treatment in separate sections following the general discussions. These sections summarize the contamination potentials of mercury, vanadium, nickel, fluorocarbons, and pulp and paper production, respectively. (See also W71-03771)

#### DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT. VOLUME II. THE OVERVIEW SYSTEM,

Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

G. A. Lutz, S. B. Gross, J. B. Boatman, P. J. Moore, and R. L. Darby.

Available from NTIS as PB-194 399, \$3.00 in paper copy, \$0.95 in microfiche. Final report, July 1967. 85 p. PHS Contract PH-86-66-165.

Identifiers: \*Hazardous materials, Evaluation, \*Pollution, \*Information centers, \*Public health, Human ecology, Toxic diseases, Data processing, Management systems, Warning systems, Forecasting, \*Environmental health hazards, \*Environmental health overview centers.

The United States Public Health Service, Office of Environmental Health, conceived a project to develop a mechanism for evaluating existing information and reducing it to manageable proportions and forms which would enable it to better carry out its responsibilities in research and control programs. The needed mechanism was considered to be a system which would provide an overview and identification of those activities which might lead to public-health hazards. A system design study verified this concept utilizing an overview information center to provide the necessary hazards-identification, evaluation, and alerting system. (See also W71-03770)

W71-03771

#### DIGITAL SYSTEMS FOR ON-SITE DATA COLLECTIONS FOR WATER QUALITY ANALYSIS,

Arkansas Univ., Fayetteville. Water Resources Research Center.

M. K. Testerman.

Available from NTIS as PB-197 116, \$3.00 in paper copy, \$0.95 in microfiche. Arkansas Water Resources Research Center, Publication No. 8, Fayetteville, 1970. 58 p, 2 tab, 26 fig, 3 ref, append.

Descriptors: \*Data processing, Design criteria, Digital computers, Electronic equipment, \*On-site data collection, \*Monitoring, \*Data transmission, \*Data collections, Water quality, \*Pollutant identification, Analytical techniques, Instrumentation.

A prototype system has been developed for recording and transmitting digital data at a remote water quality monitoring station in an unattended manner. As many as eight analog signals from transducers, which measure water quality characteristics such as dissolved oxygen, temperature, pH, chlorides, conductivity, redox, and turbidity, are converted to digital signals and recorded in binary coded decimal format on magnetic tape. This unit may be contacted from a central station for playback of the day's recording. The transmitted data can be recorded at the central station by teletype. Each data record includes a time-of-day 'word' so that all data is identifiable. The techniques developed during this contract period have possible application in many areas of water resource research, particularly for use in making water quality measurements in remote areas or at numerous sites report to one central station.

W71-03782

## 5B. Sources of Pollution

#### RELATIONSHIP BETWEEN POLLUTION INDICATOR ORGANISMS AND THE SALINITY OF MISSISSIPPI'S ESTUARINE WATERS,

Gulf Coast Research Lab., Ocean Springs, Miss.

For primary bibliographic entry see Field 05A.

W71-03387

#### SOME CONSIDERATIONS FOR WATER QUALITY AND ENVIRONMENTAL PROTECTION IN WILD AND SCENIC RIVER DEVELOPMENT: THE CHATTOOGA RIVER - A CASE STUDY,

Forest Service (USDA). Southern Region.

For primary bibliographic entry see Field 05G.

W71-03388

#### TEMPERATURE STUDIES OF AN INTERTIDAL ZONE OF AN ESTUARY,

Central Electricity Generating Board, London (England).

J. F. Spencer.

## WATER QUALITY MANAGEMENT AND PROTECTION—Field 05

### Sources of Pollution—Group 5B

Symposium on Marine Biology, October 2, 1969, p 8-11. 8 fig. Laboratory Memorandum RD/L/M/269.

Descriptors: \*Thermal pollution, \*Water temperature, \*Estuaries, Heat transfer, Instrumentation, \*Tidal effects, Nuclear power plants.

Identifiers: Temperature gradients, Blackwater Estuary.

In order to understand the effect of additional temperature variations due to power station operation, it is necessary to study the natural seasonal temperature ranges and the frequency and magnitude of the short term temperature variations of the intertidal zone. An automatic data-recording system with thermistor probes for measuring the temperature of intertidal zones is described. During a single low tide period, variations in temperature of up to 10 deg C and rates of change in temperature of 1 deg C/min have been recorded 1 cm below the surface. At a depth of 20 cm the changes in temperature were slight. The temperature gradient in the soil may at times change rapidly. The intertidal zone acts as a variable area radiator constantly absorbing and re-radiating heat. In the Blackwater Estuary the heat exchanged at spring flood tides, when the intertidal zone is cooled to a depth of 30 cm by an average of 1 deg C, was estimated to be about  $6.0 \times 10^9$  to the 12th power cal (24 Tera Joules). This value is equivalent to one-third of the heat discharged by Bradwell Nuclear Power Station (360 MW capacity) in 24 hours. The results of some observations in Milford Haven are also given. (Upadhyaya-Vanderbilt)

W71-03467

#### SAMPLING CONSIDERATIONS IN STREAM DISCHARGE AND TEMPERATURE MEASUREMENTS,

Pittsburgh Univ., Pa.

For primary bibliographic entry see Field 07B.

W71-03476

#### HEATED SURFACE JET DISCHARGED INTO A FLOWING AMBIENT STREAM,

Vanderbilt Univ., Nashville, Tenn. Dept. of Environmental and Water Resources Engineering.

Louis H. Motz, and Barry A. Benedict.

Available from Vanderbilt University School of Engineering, Nashville, Tenn. 37203. Price: \$3.00. National Center for Research and Training in the Hydrologic and Hydraulic Aspects of Water Pollution Control, Report No 4, August 1970. 207 p, 75 fig, 16 tab, 48 ref.

Descriptors: \*Cooling water, \*Thermal pollution, \*Jets, \*Turbulent flow, \*Heated water, \*Thermal power plants, Thermal stratification, Diffusion, Water temperature, Heat exchange, Temperature.

Identifiers: \*Heat discharge, Density differences, Buoyant Jets, Ambient Fluids, Temperature profiles, Widows Creek, New Johnsonville, Waukegan Surveys.

The temperature distribution in the water body due to a discharge of waste heat from a thermal-electrical plant, is a function of the hydrodynamic variables of the discharge and the receiving water body. The temperature distribution can be described in terms of a surface jet discharging at some initial angle to the ambient flow and being deflected downstream by the momentum of the ambient velocity. This report considers only the problem of surface jets. It is assumed that in the vicinity of the surface jet, heat loss to the atmosphere is negligible. It is concluded that the application of the two dimensional surface jet model is dependent on the velocity ratio and the initial angle of discharge, the value of the initial Richardson number, as low as 0.22, and the intensity of the ambient turbulence. The temperature distribution can be described in terms of a surface jet, as long as the initial direction of the discharge velocity is significantly different from the direction of the ambient current. Both laboratory and field data are used for verification of the model which has been developed. (Herrera-Vanderbilt)

W71-03478

#### AGRICULTURE POSES WASTE PROBLEMS.

Environmental Science and Technology, Vol 4, No 12, p 1098-1100, December 1970. 2 fig.

Descriptors: \*Farm wastes, \*Pollutants, \*Wastes identification, \*Environmental effects, Water pollution sources.

Identifiers: \*High intensity farming, Contamination, Plant emissions, Government action.

Increasing concentration and intensity of agricultural activities necessary to the development and prosperity of the economy, are responsible for many new environmental issues. Primary sources of pollution resulting from agricultural practices can be grouped as: animal wastes, wastes from processing of raw agricultural products, rural domestic wastes, and sediment from land; also plant nutrients from fertilizers, inorganic salts and minerals resulting from irrigation, pesticides, aeroallergens and infectious agents contribute to the problem; particulate and gaseous substances derived from the combustion of wastes and natural plant emissions add to the problem. A brief description of these sources and some possible solutions are presented. (Christenbury-Iowa State)

W71-03537

#### URINARY CREATININE AS AN INDEX COMPOUND FOR ESTIMATING RATE OF EXCRETION OF STEROIDS IN THE DOMESTIC SOW,

Purdue Univ., Lafayette, Ind.

For primary bibliographic entry see Field 05A.

W71-03538

#### RELATIONSHIP OF AGRICULTURE TO SOIL AND WATER POLLUTION.

Cornell Univ., Ithaca, N.Y.

Proceedings, Cornell University Conference on Agricultural Waste Management, January 19-21, 1970. Ithaca, 1970. 270 p.

Descriptors: \*Soils, \*Farm wastes, \*Fertilizers, Groundwater, Precipitation, Potassium, Poultry, Cattle, Hogs, Nitrogen, Nitrate, Phosphorus, Phosphates, Rates of application, Nutrients, Effluent, Aquifer, Ammonia, Soil contamination, Water pollution, Water table, Oxidation lagoon, Irrigation, Aeration, Biochemical oxygen demand, Chemical oxygen demand, Odor, Biological treatment, Costs, Denitrification, Nitrification, Sludge, Storage, Nutrient requirements, Florida, Nebraska, Surface runoff, Infiltration.

Identifiers: \*Feedlots, Oxidation ditch, Slotted floors, Aerator, Spreading, Land disposal.

The 1970 Conference attempted to bring knowledgeable individuals from many disciplines together to discuss various aspects of the problem. It was designed to serve as a mechanism for transmitting new research findings to those interested in this area and to demonstrate that agriculture is aware of its potential contributions to environmental pollution as well as its responsibility to society to find methods of alleviating such pollution while increasing the efficiency of production. The Conference played a useful role in providing communication across disciplines. Thirty-two papers are published in the proceedings dealing with all areas of agricultural pollution. (See also W71-03543 thru W71-03554) (White-Iowa State)

W71-03542

#### GROUNDWATER QUALITY AND FLUCTUATIONS IN A SHALLOW UNCONFINED AQUIFER UNDER A LEVEL FEEDLOT,

Department of Agriculture, Lincoln, Nebr. L. N. Mielke, J. R. Ellis, N. P. Swanson, J. C. Lorimor, and T. M. McCalla.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management,

Rochester, January 19-21, 1970, Ithaca, 1970, p 31-40. 2 tab, 4 fig, 13 ref.

Descriptors: \*Farm wastes, \*Cattle, \*Groundwater, \*Nitrate, Aquifer, Discharge, Aquifer characteristics, Effluent stream, Groundwater recharge, Transmissivity, Water level fluctuations, Ammonia, Nebraska, Soil contamination, Observation wells, Water table, Infiltration.

Identifiers: \*Feedlot, Platte River Valley.

The quality was investigated of the groundwater in the proximity of a level feedlot on a permeable soil with fluctuating high water table. At the feedlot site, the aquifer consists of 30-35 feet of high quality gravel having a coefficient of transmissibility in the range of 90,000-120,000 gallons per day per foot. Aquifer recharge occurs as a result of direct precipitation and interflow from the valley uplands. Six observation wells were installed in the vicinity of the feedlot as well as six water level measuring wells. Two recording wells, constructed of 4-inch diameter aluminum irrigation pipe, were jetted into the gravel aquifer. The water table depth at the feedlot varies with the season. Groundwater level changes reflect major rainstorms within hours after the event. The maximum groundwater elevation under the feedlot was approximately 2 feet below the soil surface. Soil cores were taken to determine the quantity of nitrate which could move into the water table. Low levels of nitrate were found below the first foot. Ammonia was present in only moderate amounts below 3 feet (A30ppm) and rapidly decreased in concentration with increased depth to the water table. Analysis of the core samples indicated that downward movement of nitrates and other forms of nitrogen in the soil was minor. The 12-15 inches of manure pack decreased the actual penetration depth of the nitrogen into the profile. Some samples exhibited levels of nitrate that exceeded Public Health standards (10ppm). This may have been due to the application of anhydrous ammonia prior to the first irrigation. Generally, the nitrate analysis showed relatively low nitrate level in the profile. (See also W71-03542) (White-Iowa State)

W71-03543

#### THE NITROGEN CYCLE OF A DAIRY FARM,

Connecticut Agricultural Experiment Station, New Haven.

C. R. Frink.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 127-133. 4 fig, 1 tab, 11 ref.

Descriptors: \*Nitrogen, \*Nitrogen cycle, Farm wastes, Nutrients, Fertilization, Foliar application, Corn, Silage, Efficiencies, Nitrate, Groundwater, Ureas.

Identifiers: \*Nitrogen conversion, Yield, Foliar fertilization.

Analyses of nutrient cycling on dairy farms in the Northeast have shown that significant quantities of nitrogen may be lost to groundwater. Calculations of the efficiency of nitrogen conversion on these farms revealed that losses to the environment increased dramatically as farm size decreased. Milk production was not affected by the increased nitrogen imported onto the farm while yields of corn silage increased only slightly. Thus, the total nitrogen imported onto the smaller farms could apparently be reduced without seriously reducing productivity. In addition, losses to the environment during cycling of the required amounts of nitrogen can be reduced by foliar applications to the growing crop, selection of varieties with high yield and nitrogen content, increased plant populations, and more extensive use of cover crops. (See also W71-03542) (White-Iowa State)

W71-03549

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B—Sources of Pollution

**HYDROLOGIC STUDIES FOR EVALUATION OF THE POLLUTION POTENTIAL OF FEEDLOTS IN EASTERN NEBRASKA,**  
Department of Agriculture, Lincoln, Nebr.

Norris P. Swanson, Lloyd N. Mielke, and Jeffery C. Lorimor.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 226-232. 15 ref.

Descriptors: \*Farm wastes, \*Cattle, \*Runoff, Overland flow, Surface runoff, Infiltration, Water pollution, Erosion, Evaporation, Discharge, Settling basins, Precipitation, Slopes, Storage, Time, Nebraska.

Identifiers: \*Feedlots, Mulch, Water stage recorder, Manure pack, Intensity.

Four questions are discussed which arise as a result of large numbers of cattle contained in feedlots in eastern Nebraska. There were two primary objectives of the research. First, the annual water balance of the feedlots was to be defined. The second objective was to characterize the water leaving the feedlots in overland flow or by percolation through the profile. The data collected provide only rough comparison, but should serve to put the probable runoff, erosion, and infiltration, or retention of water on a feedlot into perspective with the better known hydrologic characteristics of cropped land. In eastern Nebraska, this can be summarized as follows: (1) Infiltration on an established beef feedlot appears to be restricted to water storage in the manure pack, with very limited water movement through the profile; (2) the runoff from a feedlot, and hence the pollution potential, is a function of the area of the lot; (3) annual runoff from a beef feedlot may be two or three times that of adjacent cropland, and (4) despite increased runoff in comparison adjacent cropland, the protective mulch of the manure pack keeps erosion losses below those of the cropland. (See also W71-03542) (White-Iowa State)  
W71-03551

**A BALANCE SHEET METHOD OF DETERMINING THE CONTRIBUTION OF AGRICULTURAL WASTES TO SURFACE WATER POLLUTION,**  
Cornell Univ., Ithaca, N.Y. Dept. of Agricultural Economics.

David A. Schultz.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 251-262. 8 tab, 9 ref.

Descriptors: \*Water quality, \*Farm wastes, \*Nutrients, Nitrogen, Phosphorus, Potassium, Fertilizers, Water pollution, Sediments, Pesticides, Regions, Basins, Time.

Identifiers: \*Balance Sheet Method, Nutrient losses, Biologic inputs.

To the extent that the data are accurate, the paper presents a Balance Sheet Method that will show explicitly the quantity of nutrients contributed by agricultural activities to a stream. From this, one can determine the relative importance of agricultural pollution given knowledge of the total amount of nutrient pollution. Combining this information with that available on water quality and contributions from other sources, a waste management association will be able to more accurately determine the share that the agricultural industry will have to pay of the total cost of a program to maintain an abundant quantity of good quality water for all uses. Using this general method as well as modifying and improving the procedure will aid society's efforts toward effective water pollution control for all rivers and lakes in the United States. (See also W71-03542) (White-Iowa State)  
W71-03553

**DISTRIBUTION OF ARSENIC FROM POULTRY LITTER IN BROILER CHICKENS, SOIL, AND CROPS,**  
Salisbury Labs., Charles City, Iowa. Dept. of Biochemistry.  
For primary bibliographic entry see Field 05A.  
W71-03565

**SURFACE RUNOFF AND NUTRIENT LOSSES OF FENNIMORE WATERSHEDS,**  
Wisconsin Univ., Madison. Dept. of Agricultural Engineering, State of Wisconsin.  
For primary bibliographic entry see Field 05A.  
W71-03571

**THE FARM ROLE IN WATER QUALITY MANAGEMENT,**  
Soil Conservation Service, Beltsville, Md.  
Hollis R. Williams.  
Water and Sewage Works, Vol 115, October 1968, p 463-464.

Descriptors: \*Farm wastes, \*Sediments, \*Fertilizers, Insecticides, Herbicides, Water pollution, Watershed Protection and Flood Prevention Act, Channels, Cattle, Poultry, Pollution abatement.  
Identifiers: Soil Conservation Service.

This article is based on information contained in an address by Williams to the Federal Water Quality Association. It is stated that three things find their way from farm lands into waterways to form major pollution problems. These are sediment, agricultural chemicals, and animal wastes. Sediment is the most significant of the three. Sediment also adsorbs phosphate and pesticides and carries them in streams. The major source of sediment is farmland, however, housing developments, new roads and other construction produces extremely large quantities of sediment. Four areas are mentioned which need continuing attention to control the erosion problem. The increased use of fertilizer is pointed out along its pollution capabilities. Research is currently being done to study the behavior of fertilizers, insecticides and herbicides on soils, water and plants. The problem of animal waste is also discussed. Four tools are pointed out as being necessary to achieve the goal of clean rivers and streams and successful control of pollution on farmlands as well as urban areas. (White-Iowa State)  
W71-03572

**NITRATE AND OTHER WATER POLLUTANTS UNDER FIELDS AND FEEDLOTS,**  
Agricultural Research Service, Fort Collins, Colo.  
Soil and Water Conservation Research Div.  
For primary bibliographic entry see Field 05A.  
W71-03575

**SOURCES OF NITROGEN AND PHOSPHORUS IN WATER SUPPLIES - TASK GROUP REPORT.**

Journal of the American Water Works Association, Vol 59, p 344-366, March 1967. 8 tab, 1 fig, 64 ref.

Descriptors: \*Nitrogen, \*Phosphorus, Farm wastes, Eutrophication, Great Lakes, Distribution, Fertilizers, Ammonia, Nitrates, Nitrates, Phosphorus, Compounds, Domestic wastes, Detergents, Industrial wastes, Nutrients, Fuels, Water treatment, Rivers, Runoff, Drainage water, Sediment transport, Cultivated lands, Water fowl, Atmosphere, Rainfall, Nitrogen fixation.  
Identifiers: \*Fertilizer consumption, Concentrations, Urban runoff, Dustfall, Historical trends.

The results of this survey have indicated that nitrogen and phosphorus nutrients are contributed to water in significant quantities from a variety of man-made and natural sources. Data taken from a small scale were extrapolated to large areas of the country. This brings attention both on the sources of most significance as well as on the sources for which additional information is most needed. The

estimation of nutrient contributions from various sources is presented in tabular form. The complete elimination of nitrogen and phosphorus nutrients from surface water supplies does not appear economically feasible because the sources are so widespread. Therefore, appropriate efforts must be made to cope with many of the problems that have been created, and increased effort must be devoted to the development of better methods for prevention of algal growth in reservoirs. A more concentrated effort by the water utility profession to reduce the detrimental effects caused by eutrophication of water supplies is recommended. (White-Iowa State)  
W71-03577

**SOIL POLLUTANTS: THEIR ORIGIN AND BEHAVIOR,**  
Guelph Univ. (Ontario). Dept. of Microbiology.  
D. E. Elrick, J. W. Biggar, and L. R. Webber.  
Journal Soil Water Conservation, Vol 21, p 7-11, 1966. 3 fig, 26 ref.

Descriptors: \*Pollutants, \*Pesticide residues, \*Degradation (Decomposition), Farm wastes, Pollutant identification, Effluents, Pesticides, Sewage, Domestic wastes, Disposal, 2-4-D, DDT, Chlorides, Radioactive wastes, Air pollution effects.

Identifiers: \*Contaminants, Biological contaminants.

Pesticides, industrial and municipal wastes, radioactive materials, microbes, and other potential pollutants are coming in contact with our soils in ever increasing amounts. This article discusses certain sources of soil contaminants and outlines a few of the research techniques being used in an attempt to understand their behavior in soils. Agricultural chemicals may become harmful pollutants if improperly used. Sewage and industrial wastes make up the bulk of contaminating substances produced by our society. Waste disposal is related to biological contamination of water supplies by bacteria and viruses. Radioactive contamination and some air pollutants come into contact with the soil. The movement of some of the soil pollutants is discussed. (Christenbury-Iowa State)  
W71-03580

**A GENERAL NUMERICAL SOLUTION OF THE TWO-DIMENSIONAL DIFFUSION-CONVECTION EQUATION BY THE FINITE ELEMENT METHOD,**  
California Univ., Davis.

G. L. Guymon, V. H. Scott, and L. R. Herrmann.  
Water Resources Research, Vol 6, No 6, p 1611-1617, December 1970. 7 p, 3 fig, 11 ref. NSF Grant GZ-790.

Descriptors: \*Diffusion, \*Convection, \*Linear programming, Mathematical studies, Equations, Computer programs, Numerical analysis, Dispersion, Porous media, Flow, Open channel flow.  
Identifiers: \*Finite element analysis.

The two-dimensional diffusion-convection equation, together with the appropriate auxiliary conditions, is used to describe approximately the motion of dissolved constituents in porous media flow, dispersion of pollutants in streams and estuaries, energy transfer in reservoirs, and other natural transport processes. The two-dimensional diffusion-convection equation, with an assumed set of auxiliary conditions, is converted to a variational principle for systems that do not involve mixed partials. The variational principle is in turn solved by the Ritz procedure by dividing the domain of interest into an arbitrary number of finite triangular elements. Within each element the unknown function states are represented by a first order space polynomial. The resulting system of first order linear equations is then solved by numerical differentiation using the Adams-Moulton multistep predictor-corrector method. (Knapp-USGS)  
W71-03677

## Effects of Pollution—Group 5C

**NUMERICAL SOLUTION TO THE CONVECTIVE DIFFUSION EQUATION,**  
Battelle-Northwest, Richland, Wash.  
C. A. Oster, J. C. Sonichsen, and R. T. Jaske.  
Water Resources Research, Vol 6, No 6, p 1746-1752, December 1970. 7 p, 3 fig, 1 tab, 4 ref. AEC Contract AT (45-1)-1830.

Descriptors: \*Mixing, \*Numerical analysis, \*Diffusion, \*Dispersion, \*Path of pollutants, Water pollution effects, Convection, Translocation, Mathematical studies, Streamflow, Turbulent flow, Computer programs.  
Identifiers: \*Pollutant transport.

A numerical solution to the convection diffusion equation is discussed. The case examined treats a conservative waste or pollutant, although the system is flexible enough to accommodate nonconservative substances. The numerical approximation appears stable and can be extended to include analysis of an n-dimensional array. (Knapp-USGS)  
W71-03690

**DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT VOLUME I TEST-CASE STUDIES,**  
Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.  
For primary bibliographic entry see Field 05A.  
W71-03770

**DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT. VOLUME II. THE OVERVIEW SYSTEM,**  
Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.  
For primary bibliographic entry see Field 05A.  
W71-03771

## 5C. Effects of Pollution

**MANIPULATION OF RESERVOIR WATERS FOR IMPROVED QUALITY AND FISH POPULATION RESPONSE,**  
Wisconsin Dept. of Natural Resources, Madison.  
For primary bibliographic entry see Field 05G.  
W71-03307

**EFFECT OF DDT ON TEMPERATURE SELECTION BY YOUNG ATLANTIC SALMON, SALMO SALAR,**  
University of Western Ontario, London. Dept. of Zoology.  
D. M. Ogilvie, and J. M. Anderson.  
Journal of the Fisheries Research Board of Canada, Vol 22, p 503-512, 1965. 4 fig, 15 ref.

Descriptors: \*Pesticides, \*DDT, \*Temperature, \*Atlantic salmon, Juvenile fishes, Chlorinated hydrocarbon, Pesticides, Acclimation, Insecticides, Water pollution effects.  
Identifiers: Sublethal doses, *Salmo salar*.

Exposure of Atlantic salmon, *Salmo salar*, underyearlings for 24 hr to sublethal doses of DDT, ranging from 5 to 50 ppb, resulted in changes in the selected temperature. Low doses produced a downwards shift in the selected temperature whereas higher doses produced an upwards shift. The DDT effect appeared to be more marked for warm-acclimated fish (17°C) than for cold-acclimated ones (8°C). Exposure of warm-acclimated fish to 10 ppb DDT or more appeared to make them extremely sensitive to cold water and there was some evidence to suggest that the lower lethal limit may have been raised. DDT may interfere with the normal thermal acclimation mechanism. (Wahtola-Washington)  
W71-03364

**A PRELIMINARY REPORT ON RAPID BIOLOGICAL INFORMATION SYSTEMS FOR WATER POLLUTION CONTROL,**  
Virginia Polytechnic Inst., Blacksburg, Va.  
John Cairns, Jr., Kenneth L. Dickson, Richard E. Sparks, and William T. Waller.  
Journal Water Pollution Control Federation, Vol 42, p 685-703, 1970. 1 tab, 22 fig, 22 ref.

Descriptors: \*Water pollution control, Systems analysis, Toxicity, \*Monitoring, Data collections, Bioindicators, Surveys, Ecosystems, Water quality, Fish, Fish physiology, Fish behavior.

The time required to generate biological information may be reduced according to preliminary results of tests of one in-stream and two in-plant biological monitoring systems studied. A Sequential Comparison Index (SCI) was developed as a rapid method for non-biologists to assess the biological consequences of pollution and express the results numerically. Fish movement patterns and heart and breathing patterns were studied in-plant. Changes in these parameters may indicate toxicant concentrations not detectable by traditional bioassays. (Wahtola-Washington)  
W71-03367

**INFLUENCE OF BODY WEIGHT ON CHRONIC ORAL DDT TOXICITY IN COHO SALMON,**  
Bureau of Sport Fisheries and Wildlife, Columbia, Mo. Fish-Pesticide Research Lab.

Donald R. Buhler, and W. E. Shanks.  
Journal of the Fisheries Research Board of Canada, Vol 27, p 347-358, 1970. 7 fig, 3 tab, 22 ref.

Descriptors: \*DDT, \*Pesticides, Weight, \*Fish diets, Mortality, Laboratory tests, Bioassay, \*Lethal limit, Pesticide removal, Toxicity, Salmon, Water pollution effects, Insecticides.

Identifiers: Coho salmon, \*LD<sub>50</sub>, Body size, \*Median survival time, \*Pesticide uptake.

Median Survival time was directly proportional to body weight in young coho salmon of the same age that were fed a diet containing technical DDT. Supplementation by additional feeding with DDT-free diet prolonged the lifespan of these fish but the median survival time remained a direct function of body weight. The primary effect of body size on lethality was to control the rate of DDT intake by the fish. The smallest fish consumed the greatest amounts of diet and, consequently, these fish received the highest milligram per kilogram doses of DDT. In addition, however, the smaller salmon succumbed to a lower milligram per kilogram cumulative lethal dose than did the larger fish, perhaps because the smallest fish contained a lower percentage of lipid and thus failed to provide for adequate storage detoxification of the DDT. (Sjolseth-Washington)  
W71-03368

**TOXICITIES OF SOME HERBICIDES TO SIX SPECIES OF FRESHWATER CRUSTACEANS,**  
Bureau of Sport Fisheries and Wildlife, Columbia, Mo. Fish-Pesticide Research Lab.

Herman O. Sanders.  
Journal Water Pollution Control Federation, Vol 42, p 1544-1550, 1970. 3 tab, 16 ref.

Descriptors: \*Pesticides, \*Bioassay, \*Toxicity, \*Crustaceans, Herbicides, Shellfish, Aquatic animals, Water pollution effects, Shrimp, Daphnia, Crayfish, Mortality, Invertebrates.  
Identifiers: TL<sub>50</sub>, Scud, Sowbug, Dichrone.

The relative toxicities of some 37 herbicides to six species of freshwater crustaceans were described. Static bioassays were conducted on scud, glass shrimp, sowbug, crayfish, daphnia, and seed shrimp. Toxic effects were measured by determining the Median Tolerance Limit (TL<sub>50</sub>) for 24-, 48-, and 96-hr exposures. The 37 herbicides not only differed greatly in toxicity but also exhibit large variations in sensitivity among the six species. The toxicities of different formulations of the same herbicide also differ greatly. Dichrone was the most

toxic herbicide tested. Herbicides were generally most toxic to daphnia; following in descending order of sensitivity were seed shrimp, glass shrimp, sowbug, scud, and crayfish. (Wahtola-Washington)  
W71-03371

**DISTRIBUTION OF INGESTED ZINC-65 IN THE TISSUES OF SOME MARINE CRUSTACEANS,**  
Oregon State Univ., Corvallis. Dept. of Oceanography.

Scott W. Fowler, Lawrence F. Small, and John M. Dean.

Journal of the Fisheries Research Board of Canada, Vol 27, p 1051-1058, 1970. 3 tab, 2 fig 20 ref. Atomic Energy Commission AT (45-1) 1830, PHS Grant ES00026.

Descriptors: \*Heavy metals, Metabolism, Crustaceans, Shrimp, Water pollution effects, \*Metals, Marine animals, Rates, Shellfish, \*Zinc radioisotopes, Radiochemical analysis, Invertebrates.

Identifiers: Euphausia pacifica, Zn-65, Thysonoesa spinifera.

Autoradiographs of tissues of euphausiids and shrimps fed 65Zn through a food chain showed the isotope located primarily in the muscle fibers, in the eye, within the exoskeleton, and on the interior surface of the exoskeleton. Comparisons of the autoradiographic evidence with concentrations of radiozinc and stable zinc in the various dissected tissues were in good agreement. The specific areas of Zinc is highly labile in marine crustaceans and will accumulate in certain specific locations regardless of the mode of uptake. The rates at which various tissues became saturated with 65Zn were dependent upon mode of uptake, however. Because most of the 65Zn was located intracellularly, and not intracellularly, most ingested zinc apparently accumulates in excess of the animal's needs and is not used metabolically. (Wahtola-Washington)  
W71-03372

**MINERALIZATION PROCESS OF ORGANIC MATTER IN LAKE WATER,**  
Nagoya Univ. (Japan). Water Research Lab.  
Tadashiro Koyama, and Takao Tomino.  
Kyoto University Misaki Marine Biological Institute Bulletin, No 12, p 111-124, February 1968. 14 p, 6 fig, 4 tab, 22 ref.

Descriptors: \*Biodegradation, \*Organic matter, \*Lakes, \*Eutrophication, \*Water chemistry, Nitrification, Solubility, Solutes, Plankton, Decomposing organic matter.

Identifiers: \*Japan.

Studies on the mineralization process of organic matter were carried out in Lake Kizaki-ko (maximum depth: 28.5m), a mesotrophic lake in Navano Prefecture, Japan. The ratio of organic carbon to organic nitrogen was 5.7 in plankton, 9.3 in detritus collected at 25 meters in water, and 15.5 in bottom sediments. During the early stage of the stagnation period, the process of nitrogen fixation is generally a little more active than denitrification, but during most of the stagnation period, denitrification remarkably exceeds nitrogen fixation. At the end of the stagnation period, the amount of denitrified N is considerably larger than other mineralized nitrogenous compounds. Denitrification constitutes the dominant process determining the nitrogen metabolism in the lake water. The average ratio of total mineralized carbon and nitrogen in the lake at the end of the stagnation period was 3.53, a value considerably smaller than the corresponding value for plankton, 5.7. This fact supports the view that the greater ease of decomposition of nitrogenous fraction of dead planktonic material as compared with that of the carbonaceous fraction causes the increase in the ratio of Org.C/Org.N towards the bottom. (Knapp-USGS)  
W71-03435

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C—Effects of Pollution

**REPORT OF NATIONALLY DESIGNATED EXPERTS ON EUTROPHICATION CONTROL.**  
Organization for Economic Co-operation and Development, Paris (France).

Organization for Economic Co-operation and Development, Ex 40103, 1970. 34 p, 5 append.

Descriptors: \*Conferences, \*Eutrophication, \*Control, \*Foreign research, Water quality, Water pollution effects, Water pollution sources, Integrated control measures, Legal aspects, Fertilizers, Detergents, Water resources, Investment, Costs.

Identifiers: \*OECD, \*Water Management Research Group, Development projects, Canada, Finland, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom, United States.

This report, submitted in 1969 by delegates of different countries, contains a review of problems and control measures of water eutrophication. The document raises several legal issues relative to the agricultural use of fertilizers and the sale of phosphorus-free detergents. Five appendices include a list of representatives of different nations, a list of submitted national reports, and proposals for measurements of essential factors of eutrophication. (Wilde-Wisconsin)

W71-03443

**SCIENTIFIC FUNDAMENTALS OF THE EUTROPHICATION OF LAKES AND FLOWING WATERS, WITH PARTICULAR REFERENCE TO NITROGEN AND PHOSPHORUS AS FACTORS IN EUTROPHICATION,**  
Organization for Economic Co-operation and Development, Paris (France).

Richard A. Vollenwider.

Organization for Economic Co-operation and Development, Ex 40105, 1970. 193 p, 34 fig, 41 tab.

Descriptors: \*Eutrophication, \*Phosphorus, \*Nitrogen, Lakes, Rivers, Impoundments, Aquatic life, Plankton, Biomass, Productivity, Trophic level, Nutrients, Water pollution control, Water pollution effects, Water pollution sources, Waste water treatment, Inorganic compounds.

Identifiers: \*OECD, \*Committee for Research Cooperation, Aquatic blooms, Hydrophytes, Nutrient sources, Nutrient concentration.

These 160 pages of text, supplemented by many diagrams (and a bibliography (See W71-03448) issued separately) are described as a report. In actuality this volume is a textbook-like monograph covering a good many aspects of inorganic water eutrophication, particularly that caused by nitrogen and phosphorus. The subjects which were given primary attention in the 7 chapters of the volume include physiology and ecology of bloom-forming organisms; relation between the biomass of plankton and trophic level of waters; sources, supply, and critical concentration of nutrients; elimination of phosphorus and nitrogen from wastewaters. A considerable fraction of the assembled information could be well incorporated into a textbook on the subject. (Wilde-Wisconsin)

W71-03447

**BIBLIOGRAPHY: SCIENTIFIC FUNDAMENTALS OF THE EUTROPHICATION OF LAKES AND FLOWING WATERS, WITH PARTICULAR REFERENCE TO NITROGEN AND PHOSPHORUS AS FACTORS IN EUTROPHICATION,**  
Organization for Economic Co-operation and Development, Paris (France).

For primary bibliographic entry see Field 10.

W71-03448

**CHANGES IN THE BLOOD OF BROOK TROUT (SALVELINUS FONTINALIS) AFTER SHORT-**

#### TERM AND LONG-TERM EXPOSURE TO COPPER,

National Water Quality Lab., Duluth, Minn.  
J. M. McKim, G. M. Christensen, and E. P. Hunt.  
Journal of the Fisheries Research Board of Canada, Vol 27, No 10, p 1883-1889, 1970. 1 tab, 1 fig, 27 ref. FWQA Project 18050 ETN 12/70.

Descriptors: \*Brook trout, \*Trout, \*Toxicity, \*Copper, Water pollution effects, Pollutant identification, Analytical techniques.

Identifiers: \*Blood change, Plasma.

Seven blood characteristics—red blood cell count (RBC), hematocrit (Hc), hemoglobin (Hb), plasma chloride (Cl), plasma glutamic oxaloacetic transaminase (PGOT), L-aspartate: 2-oxoglutarate amino transferase, osmolarity (Os), and total protein (TP)—were measured in brook trout (*Salvelinus fontinalis*) that had been exposed to three concentrations (67.5-69.2, 38.2-39.0, and 22.8-24.0 ug/liter) of Cu (II) for 6 and 21 days. Concentrations of 67.5-69.2 and 38.2-39.0 ug/liter caused statistically significant increases in RBC, Hc (6-day only), Hb, PGOT, and TP (6-day only), whereas Cl and Os decreased during both exposure periods. Five blood characteristics (RBC, Hb, Hc, Cl, and PGOT) were also measured in brook trout, which were exposed for 337 days to Cu (II) concentrations of 32.5, 17.4, 9.5, 5.7, and 3.4 ug/liter. After this long-term exposure, no changes were observed in the blood except for a measurable decrease in PGOT values at 32.5 and 17.4 ug/liter. The disappearance of initial blood changes, after extended exposure, suggests the transient nature of these early responses. Application of this study to the evaluation of the physical condition of fish and the possible long-range forecasting of reproductive success and survival of a species is discussed.

W71-03450

#### MOLLUSCS FROM A POWER STATION CULVERT,

Central Electricity Generating Board, Leatherhead (England). Central Electricity Research Labs.  
D. S. Davis, and W. R. White.  
Journal of Conchology, Vol 26, No 1, p 33-38, 1966. 2 fig, 1 tab, 6 ref.

Descriptors: Power plants, \*Fouling, \*Molluscs, \*Mussels, Water pollution effects.

Identifiers: Intake culvert.

The objective was to gain information on the fouling which may be of use in devising control measures. The samples were taken to study the settlement of the edible mussel which grows in large numbers in the culvert. If left unchecked these growths of mussels may cause reductions in the water flow and blocking of condenser tubes which can decrease the efficiency of the power station and consequently increase the cost of electricity generation. The samples collected were initially preserved in 5 percent formalin in sea water but later transferred to sea water. The collections made from the culvert have provided some 34 species. The species recorded are listed, with appropriate notes, according to the system and nomenclature employed by Winckworth. The occurrence of various mollusc species in the samples are given in a table. The many dead shells and the distorted shells of living specimens indicate the large-scale settlement of larvae on to a substrate which is totally unsuitable for the adults. This feature is particularly well shown by those pelecypods which normally have a burrowing habit, e.g. *Venerupis* and *Petricola pholadiformis*. (Upadhyaya-Vanderbilt)

W71-03470

#### SOME EFFECTS OF HEATED EFFLUENTS ON MARINE PHYTOPLANKTON,

Central Electricity Generating Board, London, (England).

P. D. V. Savage.

Symposium on marine biology, p 27-32, October 2, 1969. 3 fig, 1 tab, 4 ref. Laboratory memorandum RD/L/M 269.

Descriptors: \*Thermal pollution, \*Phytoplankton, \*Food chains, Power plants, Estuaries, Cooling water, Carbon radioisotopes, Plant physiology, Photosynthesis, Water pollution effects.

Identifiers: \*Marine environment.

Phytoplankton species, as primary producers, play a fundamental role in marine food chains. In situ measurements of the effects on phytoplankton of passage through power station condensers is made. In situ measurements of the carbon assimilation rates of natural phytoplankton populations at the different temperatures was made using the <sup>14</sup>C technique as recommended by Steemann Nielseni. Over the course of the year there appeared to be no significant difference between the carbon-assimilating capacities of heated and unheated samples. Regular microscopical examination of samples show no apparent increase in the number of dead cells in outfall samples. Effect of the duration of exposure to elevated temperatures on subsequent growth of *Isochrysis galbana* in culture is shown in two figures. Existing knowledge of algal physiology indicates that over limited temperature ranges above the optimum, the inactivation of biochemical components of cells is reversible. Such effects might well occur in marine phytoplankton. (Upadhyaya-Vanderbilt)

W71-03469

#### THERMAL POLLUTION THREAT DRAWS NEARER,

E. E. Dallaire.  
Civil Engineering, p 67-71, October 1970. 3 fig.

Descriptors: \*Thermal pollution, \*Nuclear power plants, \*Temperature, Ecology, Cooling towers, Fish.

Identifiers: Temperature standards, Waste heat.

The thermal pollution threat will be met by, disposing of excess heat through cooling towers, cooling ponds, or spray ponds, by upgrading power generating efficiency, by managing the receiving waters to reduce the harmful impact of heat on water bodies and by making use of waste heat. Increase in temperature of the water body causes increase in metabolism, decrease in reproductive ability of fish and other organisms. They become more susceptible to disease and poisoning and their ability to catch food decreases. Recent biological studies at several power plant sites around the U. S. found that thermal discharges had no significant short-term impact on aquatic life. The use of evaporative cooling tower rather than once-through systems increases the cost of generating power by about 5%. Some of the more frequently heard proposals for putting this heat to good use include space heating, industrial processes, agriculture, aquaculture, water and waste treatment, desalination, de-icing harbors, and recreation. Temperature recommendations proposed by the National Technical Advisory Committee on water quality standards are discussed. (Upadhyaya-Vanderbilt)

W71-03470

#### BENEFICIAL USES OF THERMAL WATER,

Vitro Corp. of America, Portland, Oreg. Portland Operation.

Herman H. Miller, Jr.

Thermal Water Horticultural Demonstration Project at Springfield, Oregon, Chemurgic Council 32nd Annual Conference, Washington, D.C., October 22-23, 1970. Typescript. 6 p.

Descriptors: \*Thermal water, \*Sprinkler irrigation, \*Irrigation, Water reuse, Horticulture, Demonstration farms, Drainage, Cooling water, Thermal pollution, Cooling towers.

Identifiers: Springfield, Oregon.

The utilization of thermal waters from industry in a multi-use concept that would benefit the public, industry and agriculture is treated in this paper. A field-demonstration project for agriculture is presented. Programs such as: Frost protection, plant cooling, irrigation, soil heating and drainage

## WATER QUALITY MANAGEMENT AND PROTECTION—Field 05

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studies are analyzed. A critical factor in frost protection by sprinkler application is the proper management of water application to preclude limb breakage, as a result of ice formation, which can cause breakage loss to trees that exceeds the loss caused by frost. Warm water from sprinklers can be used to cool plants during warm, dry summer months. The project demonstrates how this procedure reduces sunscald, eliminates cold water shock, increases yields and improves the quality of crops. Broad irrigation effects of thermal water are being monitored on the project. (Herrera-Vanderbilt)

W71-03471

**HEAT TRANSIENTS AND ECOLOGY,**  
Central Electricity Generating Board, London,  
(England).

N. Holmes.

Symposium on marine biology, p 50-51, October 2, 1969. 1 ref. Laboratory memorandum RD/L/M 269.

Descriptors: \*Thermal pollution, \*Ecology, Power plants, Coasts, Temperature.

Identifiers: Heat transients.

The stream of warmed water from a coastal power station may produce marked local heating effects far in excess of the average level of heating in the outfall area. As the sea surface rises and falls with the tide, this warmed layer comes into contact with varying areas of the sub-littoral zone. The behavior of shore animals under steady temperature conditions gives little guide to their probable reactions to these rapidly changing temperature. The presence of under and overshoot effects may be particularly significant. At lower, sublethal, values constantly varying temperatures affect feeding efficiency, food conversion, growth rate and gonad maturation. (Upadhyaya-Vanderbilt)

W71-03472

### PHYSICAL AND ECOLOGICAL EFFECTS OF WASTE HEAT ON LAKE MICHIGAN.

Fish and Wildlife Service, United States Department of the Interior, September 1970. 101 p, 7 fig, 14 tab, 60 ref.

Descriptors: \*Thermal pollution, \*Lake Michigan, \*Heated water, \*Aquatic environment, \*Water temperature, Fish kill, Aquatic habitats, Ecological effects, Wild life, Eutrophication.

Identifiers: \*Waste heat, \*Inshore waters, Thermal loadings, Thermal tolerances, Fishery resource.

The purpose of the present report is to analyze the ecological damages to Lake Michigan as a result of the discharge of industrial and municipal waste heat. Since not enough data are available about these effects, interview standards must be set for Lake Michigan on the basis of existing knowledge. This paper presents the available evidence that substantiates this concern. Heat addition is an essentially accumulative problem that would contribute to inshore eutrophication and be intolerable for the fish and wildlife standpoint by the year 2000. Analysis of inshore waters, thermal loadings, effects of temperature fluctuation on Lake Michigan fish and ecological ramifications of the addition of waste heat are presented and discussed. Among the conclusions based on the evidence presented in the report, it is stated that no significant amounts of waste heat should be discharged into Lake Michigan. (Herrera-Vanderbilt)

W71-03474

**WATER QUALITY AND POWER PLANTS,**  
Duke Power Co., Charlotte, N.C.

Austin C. Thies.

Edison Electric Institute Bulletin, p 201-206, June-July 1969. 9 fig.

Descriptors: \*Thermal pollution, \*Water cooling, \*Heated waters, \*Power plants, Industrial water,

Fishkill, Wildlife, Dissolved oxygen, Aquatic habitats.

Analysis and discussion on what industry has done to minimize the effect of heated discharges from power stations to the receiving waters is presented in this paper. It is stated that industries are carrying out many studies on the biological effects of heated water discharges on Biota at actual power plant sites. There is a good evidence that adding large amounts of heat to water in itself is not likely to have harmful effects on the life in and around the water at low temperatures. However, when additions are on a long series of hot days at low riverflows in areas where sewage wastes are dumped, the balance of life in and around the water will be upset in a variety of ways, some of which are harmful. Industry must avoid these kind of changes. (Herrera-Vanderbilt)

W71-03475

### MARINE BIOLOGY AND ELECTRICITY PLANNING,

Central Electricity Generating Board, London (England).

D. Clark.

Symposium on Marine Biology, October 2, 1969, p 4-7. Laboratory Memorandum RD/L/M 269.

Descriptors: \*Power plants, \*Thermal pollution, Planning, Marine plants, Cooling towers, Estuaries.

Identifiers: Siting power stations.

It is at the planning stage that the environmental impact of a new project is largely determined. A dry tower is about three times as bulky as the equivalent wet tower and is much more costly. The demands of a large modern station far exceed the dry-weather flows of even our largest rivers. With limitations on inland water resources more power stations have been established on estuaries and the coast, mostly using direct cooling. It is concluded that planning engineers and biologists must keep each other informed when a new plant is planned. (Upadhyaya-Vanderbilt)

W71-03477

### FUTURE USE OF THE CHESAPEAKE BAY FOR COOLING THERMAL DISCHARGES,

Johns Hopkins Univ., Baltimore, Md. Dept. of Geography.

Derek K. Brady, Arthur S. Brooks, Norman L. Buske, Graves L. Willard, Jr., and John F. Hoffman.

Water Sciences and Management Program, Seminar Report, July 1969, 262 p. 35 fig, 19 tab, 182 ref.

Descriptors: \*Thermal pollution, \*Thermal capacity, \*Cooling waters, Aquatic environment, Recreational activities, Solar radiation, Temperature, Stagnant water, Aquatic plants, Aquatic animals. Identifiers: \*Chesapeake Bay, \*Biological effects, \*Heat disposal.

The surface cooling and advective heat capacity of the Chesapeake Bay is estimated to be of sufficiently great magnitude to warrant the utilization of the estuary's cooling capacity. However, uniform distribution of the surplus heat over the entire surface of each subregion will be required in order to have the maximum utilization of the estuary's theoretical total heat assimilative capacity. It is stated that cooling waters from large and concentrated heat sources should be spread over as large an area as possible, without causing local disturbances to the ecology near the point of discharge. Analysis of various aspects: the Chesapeake Bay, cooling requirements of thermal power plants, heat assimilative capacity, physical aspects of thermal discharges, biological and ecological considerations are given in the present paper. (Herrera-Vanderbilt)

W71-03479

**REMOVAL OF PHOSPHATES BY SORPTION ON ACTIVATED ALUMINA,**  
Missouri Water Resources Research Center, Columbia.  
For primary bibliographic entry see Field 05D.  
W71-03518

### RELATIONSHIP OF AGRICULTURE TO SOIL AND WATER POLLUTION.

Cornell Univ., Ithaca, N.Y.

For primary bibliographic entry see Field 05B.  
W71-03542

### POLLUTION FACTORS ASSOCIATED WITH EXCESSIVE POULTRY LITTER (MANURE) APPLICATION IN ARKANSAS,

Arkansas Univ., Fayetteville. Dept. of Agronomy.

Leslie H. Hileman.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 41-47. 9 tab, 1 fig, 5 ref.

Descriptors: \*Farm wastes, \*Poultry, Water pollution, Soil contamination, Rates of application, Soil tests, Phosphorus, Potassium magnesium, Salts, Ions, Nitrates.

Identifiers: \*Poultry litter, Mono-valent ions, Di-valent ions.

There is an estimated one million tons of poultry manure or manure plus litter produced from 390 million chickens and turkeys grown in Arkansas annually. The waste manure-litter is being returned to the soil often at rates exceeding 10 tons per acre annually. The data presented indicates that soil pollution and related problems may occur. These problems can be considered as: (1) excess soluble salt, (2) chemical imbalance with particular reference to K and the mono-valent to di-valent ratio, (3) excessive nitrate production and accumulation to toxic levels in forage and farm water supplies, and (4) forages deficient in magnesium for adequate animal nutrition. Further studies are needed to understand the mechanisms by which these conditions are carried out in the soil medium so that effective measures can be taken to prevent soil and water pollution. (See also W71-03542) (White-Iowa State)

W71-03544

### INTRODUCTION,

Michigan State Univ., East Lansing. Dept. of Poultry Science.

For primary bibliographic entry see Field 05A.  
W71-03556

### THE MENACE OF NOXIOUS GASES IN ANIMAL UNITS,

Ohio State Univ., Columbus. Dept. of Agricultural Engineering.

E. Paul Taigondes, and Richard K. White.

Transactions of the ASAE, Vol 12, No 3, 1969, p 359-362, 367. 2 tab, 18 ref.

Descriptors: \*Farm wastes, \*Gases, \*Effects, Carbon dioxide, Oxygen, Ammonia, Hydrogen sulfide, Methane, Lethal limit, Toxicity, Cattle, Hogs, Poultry, Ventilation, Treatment.

Identifiers: \*Concentrations, Storage pits, Pit cleaning, Lethal situations.

The paper begins with a description of noxious gases and it is noted that animal deaths have occurred as the result of an accumulation of these gases. The gases, their properties and characteristics listed, are carbon dioxide, ammonia, hydrogen sulfide, methane, and other gases. Oxygen is listed to show its indispensability inside a confinement building. Animal response to menacing concentrations of these gases is described. A table lists different properties of the noxious gases and their physiological effects on the animals. Possibly fatal concentrations are noted, along with

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the potentially lethal situations which may bring about these concentrations. Among these situations are ventilation breakdowns, pit stirring and pit cleaning. Finally, the control of noxious gases is emphasized. Preventive measures, moderating the effects of noxious gases, and treatment of affected animals are all discussed. (White-Iowa State) W71-03574

**DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT VOLUME I TEST-CASE STUDIES,** Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

For primary bibliographic entry see Field 05A.  
W71-03770

**DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT. VOLUME II. THE OVERVIEW SYSTEM,** Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

For primary bibliographic entry see Field 05A.  
W71-03771

### 5D. Waste Treatment Processes

**MICROBIOLOGY OF SEWAGE LAGOONS-ROLE OF PURPLE SULFUR BACTERIA IN STABILIZATION OF INDUSTRIAL WASTES,** North Dakota Water Resources Research Inst., Fargo.

John W. Vennes.

Available from NTIS as PB-196 656, \$3.00 in paper copy, \$0.95 in microfiche. Research Project Technical Completion Report WI-221-010-70, July 1965-Dec 1967, April, 1970. 16 p, 8 tab, 29 ref. OWRR Project A-003-NDAK (1).

Descriptors: Microbiology, \*Sewage lagoon, Coliforms, Enteric bacteria, Biochemical oxygen demand, Temperature, Hydrogen ion concentration, Sulfides, \*Sulfur bacteria, Sulfates, \*Bacteria, Industrial wastes, \*Oxidation ponds, Stabilization, Microorganisms.

Identifiers: Purple sulfur bacteria, Algal populations.

Ecologic relationships among various lagoon organisms and chemical and physical parameters of the lagoon were attempted. Pure cultures of the purple sulfur bacteria, *Chromatium vinosum* and *Thiocapsa florisana* were characterized with respect to optimum pH, temperature, and a variety of organic substrates. Purple sulfur bacteria reached maximal populations in the lagoon during the summer months when levels of acetic, butyric, and propionic acids were being depleted. Sulfide apparently was being liberated from sulfate by sulfate reducing bacteria. Methane bacteria reached their peak after sulfide disappeared from the lagoon and while formate utilization was reaching its maximal amount. Coliform, fecal coliform, and enterococci did not increase in the lagoon during the summer months. Algal populations remained minimal during the purple sulfur stage and increased approximately one log thereafter. Experimental and actual lagoon substrate determinations suggest that the purple sulfur bacteria are predominantly responsible for the utilization of volatile fatty acids from the lagoon. Furthermore, the majority of the BOD in the lagoon may be attributed to these volatile acids. A variety of microbial and chemical determinations were made. (See also W70-03312)  
W71-03301

**COAGULATION TESTING: A COMPARISON OF TECHNIQUES,** Wisconsin Univ., Madison. Water Resources Center.

Rudy J. Te Kippe, and Robert K. Ham.

Available from NTIS as PB-196 666, \$3.00 in paper copy, \$0.95 in microfiche. Water Resources Center, University of Wisconsin, Madison, Wisconsin 53706, 1970. 58 p, 17 fig, 1 tab, 38 ref. OWRR Project A-028-WIS (2).

Descriptors: \*Coagulation, \*Turbidity, \*Colloids, \*Waste water treatment, Laboratory tests, Alum, Filtration, Hydrogen ion concentration.

Identifiers: Residual turbidity, Filtered turbidity, \*Refiltration, Colloid titration, Sensitivity.

The literature indicates that over twenty different tests have been used for the purpose of evaluating the coagulation of turbidity in water treatment. Five of these tests were selected for study as they were felt to be basic and/or particularly important. These include: residual turbidity, filtered turbidity, refiltration, colloid titration, and a continuous pilot scale filter process. The five methods were compared holding all variables other than pH and alum dose constant. While some tests were shown to strongly correlate with others, the results of the refiltration technique were found to be biased in favor of low alum concentrations, and the colloid titration test was found to lack sensitivity with respect to variations in alum dosage but was quite sensitive to pH changes. The practical implications of this study suggest that water treatment plants should follow guidelines given for choosing the most useful test for their process. (See also W71-03313)  
W71-03312

**COAGULATION TESTING: A COMPARISON OF TECHNIQUES, PARTS I AND II,** Wisconsin Univ., Madison. Dept. of Civil Engineering.

Rudy J. Te Kippe, and Robert K. Ham.

Journal of the American Water Works Association, Vol 62, No 9, p 594-602, Sept 1970; Vol 62, No 10, p 620-628, October 1970. OWRR Project A-028-WIS (1).

Descriptors: \*Coagulation, \*Turbidity, \*Colloids, \*Waste water treatment, Laboratory tests, Alum, Filtration, Hydrogen ion concentration.

Identifiers: Residual turbidity, Filtered turbidity, \*Refiltration, Colloid titration, Sensitivity.

Coagulation to remove particulate matter from turbid waters may be carried out by any of several techniques. This report attempts to discover which coagulation techniques yield comparable results, and which of these is preferable from the operator's standpoint. (See also W71-03312)  
W71-03313

**EFFECT OF SODIUM CHLORIDE AND SODIUM SULFATE ON SLUDGE DIGESTION,** Georgia Inst. of Tech., Atlanta. Engineering Experiment Station.

Robert S. Ingols, Richard E. Robert, Jr., Ekkehard Gasper, and Popet Vira.

Available from NTIS as PB-196 732, \$3.00 in paper copy, \$0.95 in microfiche. Final Report to Federal Quality Administration, Project B-338, September 1970. 40 p, 5 tab, 13 fig, 7 ref. FWQA Program 17070 DYF - 09/70.

Descriptors: Waste water treatment, \*Sludge treatment, \*Sludge digestion, \*Biodegradable detergents, \*Sodium sulfate, \*Sodium chloride, Ion exchange, Textiles, Microorganisms, Ions, Aerobic treatment, Foaming, Flocculation.

Identifiers: Industrial waste treatment, Sulfide ion effects, \*Textile mill wastes.

High concentrations of sodium chloride and sodium sulfate have been observed in a town with a high concentration of textile mills. Sludge digestion was very poor. A toxic synergism between sodium chloride and sodium sulfate (sulfide) was hypothesized. Data indicated a marked reduction in gas production through a bi-sulfide ion effect upon the first stage microorganisms. The methane organisms appeared to starve rather than suffer a toxic effect from an accumulation of first stage by-

products. Inert salt concentration had very little effect. Biodegradable synthetic detergents now used in place of salt to cause dye uptake require long periods of aerobic treatment because of interference by foam in floc development.

W71-03452

**DEVELOPMENT OF A PORTABLE PILOT PLANT TO DEMONSTRATE REMOVAL OF CARBONACEOUS, NITROGENOUS, AND PHOSPHORUS MATERIALS FROM ANAEROBIC DIGESTER SUPERNATANT AND SIMILAR PROCESS STREAMS,** FMC Corp., Santa Clara, Calif. Central Engineering Labs.

George E. Bennett.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. 167, 13/4; 17010 FKA-05/70 paper copy \$1.00. Also available from NTIS as PB-196 733, \$0.95 in microfiche. Water Pollution Control Research Series ORD-17010 FKA 05/70, May 1970. 73 p, 16 tab, 15 fig, 4 ref, append. FWQA Program 17010 FKA - 05/70, Contract No. 14-12-414.

Descriptors: \*Waste water treatment, Sludge treatment, Nutrients, Nitrogen compounds, Phosphorus compounds, \*Anaerobic digestion, Digestion.

Identifiers: \*Phosphorus Removal, \*Nitrogen Removal, \*Nutrient removal, Ammonia stripping, \*Digester supernatant, Lime precipitation.

Digester supernatant contains high concentrations of nitrogen and phosphorus, also, poor quality supernatant discharged from an anaerobic digester can have an adverse effect on the overall efficiency of a waste water treatment plant. FMC Corporation undertook to build and demonstrate the operation of a unique, trailer-mounted, and completely self-contained pilot plant. The pilot plant is designed to investigate the improvement of digester supernatant quality, with particular emphasis on the removal of nitrogen and phosphorus. The pilot plant treatment sequence consists of carbon dioxide removal via air-stripping, lime precipitation of phosphorus and carbonaceous particulate matter, and removal of nitrogen by packed-tower ammonia-stripping. The pilot plant was operated over a two-month period at a trickling filter plant where two-stage anaerobic digestion is practiced. The pilot plant operated in a reliable and consistent fashion with respect to both the mechanical performance and the process data obtained. A wide range of operating conditions was investigated in a convenient and effective manner. It was found that 80-95% of supernatant phosphorus could be removed at a lime dosage equal to 50 pounds of hydrated lime per pound of phosphorus removed. Average ammonia-nitrogen removal was 82%, achieved at an air flow rate equal to 83,000 cubic feet of air per pound of NH<sub>3</sub>-N removed. Normal lime precipitation removed about one-half of the supernatant TOC, COD, and Organic Nitrogen. The average decrease in suspended solids was 64%.  
W71-03453

**PHOSPHORUS REMOVAL USING CHEMICAL COAGULATION AND A CONTINUOUS COUNTERCURRENT FILTRATION PROCESS,** Johns-Manville Research and Engineering Center, Manville, N. J.

G. R. Bell, D. V. Libby, and D. T. Lordi.

Available from NTIS as PB-196 734, \$3.00 in paper copy, \$0.95 in microfiche. Water Pollution Control Research Series 17010 EDO -- 06/70, June 1970. 58 p, 11 tab, 9 fig, 7 ref. FWQA Program 17010 EDO, Contract 14-12-154.

Descriptors: \*Phosphates, \*Waste water treatment, Electrolytes, Effluents, \*Filtration, \*Trickling filters, Municipal wastes, Sewage effluents, Sludge disposal, Biochemical oxygen demand.

Identifiers: \*Phosphorous removal, Orthophosphates, Alum.

## Waste Treatment Processes—Group 5D

The Johns-Manville Moving Bed Filter, a continuous precipitation and countercurrent filtration process, was evaluated for the removal of phosphorus from municipal wastewater. Using alum and an anionic polyelectrolyte, the process was found to effectively reduce total phosphorus (TP), orthophosphate (OP) and condensed phosphate (CP) over a wide range of influent phosphorus concentrations. Preliminary work using jar tests established an alum dose of 200 mg/l (17.4 mg/l Al, molar ratio of Al/P is 27/31) as effective for removal of 90 percent TP from the secondary clarifier effluent of a trickling filter plant. This removal efficiency could not be sustained with an alum dose of 200 mg/l when higher TP levels were encountered. With total phosphorus concentrations on the order of 25 to 28 mg/l as P (Al/P = 0.6-0.7), the TP removal efficiency averaged 90 per cent. With lower total phosphorus concentrations, removal efficiency averaged 95 per cent and ranged up to 99 per cent (Al/P = 1.2-2.6). Substantial reductions in final effluent total suspended solids (TSS) and 5-day biochemical oxygen demand (BOD<sub>5</sub>) were also obtained. At an alum dose of 200 mg/l, TSS reduction averaged 70 per cent and BOD<sub>5</sub> reduction 80 per cent. If phosphorus removal were not a design consideration, the reduction of TSS and BOD<sub>5</sub> could be achieved with lower alum doses. The 200 mg/l alum dose was also found to be equally effective for removal of phosphorus from raw sewage and primary effluent with the added capability for removing substantial portions of the TSS and BOD<sub>5</sub>. In short studies on these streams, effluent as good or better than the final effluent from the trickling plant was obtained. Costs for a 1.0 MGD plant are estimated to be \$264,000 for capital and 12.0 cents per 1000 gal for total operating cost. These costs would be about the same for raw sewage, final effluent or the two intermediate levels of prior treatment studied. Ultimate disposal of the phosphorus-containing sludge could be achieved by a dewatering and landfill operation. Dewatering by means of a rotary vacuum precoat filter would require an estimated capital expenditure of \$30,000 and total cost would be 3 cents per 1000 gal of original waste water treated.

W71-03454

**BASIC SALINOPEN ION-EXCHANGE RESINS FOR SELECTIVE NITRATE REMOVAL FROM POTABLE AND EFFLUENT WATERS,**

Tyco Labs., Inc., Waltham, Mass.

A. L. Walitt, and H. L. Jones.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Price \$1.00. 167, 13/4:17010 FKF 12/69 paper copy \$1.00. Available from NTIS as PB-196 735, \$0.95 in microfiche. Water Pollution Control Research Series, ORD 17010 FKF 12/69. Advanced Waste Treatment Research Laboratory, Cincinnati, Ohio, December 1969. 88 p, 17 tab, 10 fig, 28 ref, 2 append.

**Descriptors:** \*Ion exchange, \*Waste water treatment, \*Resins, Ions, Nitrates, Chlorides.

**Identifiers:** \*Nitrate ions, \*Nitrate removal, Resin synthesis, Weak-base resins, Resin regeneration, Ion selectivity, Ion capacity, Styrenes, Chloride ion.

Preparation of nitrate-specific ion-exchange resins, which incorporate selected primary amines grafted onto polystyrene, has been investigated. The best selectivity for nitrate ion over chloride ions was obtained with the 1-naphthylmethyl-aminomethyl derivative of polystyrene (1-NMA resin). Nitrate was adsorbed quantitatively from feed solutions containing five times as much chloride ion as nitrate ion. Under identical conditions, commercial weak-base resins removed only 70% of the nitrate ion. The 1-NMA resin could be regenerated repeatedly in the chloride form by HCl, but attempts at alkaline regeneration led to irreproducible results. Recommendations for future work include investigation of the effects of cross-linking, addition of hydrophilic functional groups, quaternization of the amine, and incorporation of different, nitrate-selective, functional groups.

W71-03455

**KINETICS AND MECHANISM OF PRECIPITATION AND NATURE OF THE PRECIPITATE OBTAINED IN PHOSPHATE REMOVAL FROM WASTE WATER USING ALUMINUM (III) AND IRON (III) SALTS,**

Atomics International, Canoga Park, Calif.

Harold L. Recht, and Masood Ghassemi.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402. Price \$0.75. 167, 13/4: 17010 EKI 04/70 paper copy \$0.75. Available from NTIS as PB-196 737, \$0.95 in microfiche. Water Pollution Control Research Series 17010 EKI-04/70. Advanced Waste Treatment Research Laboratory, Cincinnati, Ohio, April 1970. 77 p, 29 fig, 4 tab, 9 ref. FWQA Program 17010 EKI, Contract 14-12-158.

**Descriptors:** \*Phosphates, \*Kinetics, Aluminum, Iron, \*Waste water treatment, \*Chemical precipitation, \*Effluents, Chemical reactions.

**Identifiers:** \*Phosphate removal, Aluminum salts, Iron salts, Orthophosphates, Secondary effluents.

An investigation was conducted of the rate, mechanism and stoichiometry of phosphate precipitation with aluminum and ferric salts from pure phosphate solutions and secondary effluent. These studies showed that the reactions of orthophosphate ion with both Al (III) and Fe (III) are completed in less than 1 second. The effects of pH, reactant concentration, and reagent aging on the efficiency of phosphate removal were evaluated in batch precipitation experiments. The pH of optimum orthophosphate precipitation was found to be close to 6.0 for Al (III) and in the vicinity of 3.5 to 4.0 for Fe (III). With an initial orthophosphate concentration of 12 mg/l P, maximum phosphate removal was about 82% with Fe (III) and about 78% with Al (III) at a 1:1 molar ratio increasing to over 99% for both cations at a 2:1 ratio. At constant pH, with both Fe (III) and Al (III) up to about a 1:1 molar ratio, orthophosphate removal was directly proportional to amount of added cation, indicating occurrence of a chemical reaction. Dilute solutions of Fe (III) were found to undergo extensive hydrolysis on aging with a resultant loss of capacity to precipitate phosphate. The removal of condensed phosphates by precipitation with aluminum and iron salts was found to be strongly dependent on pH and the reactant concentration ratio. Precipitates obtained in the reaction of orthophosphate with aluminum and ferric salts were examined by X-ray diffraction analysis after drying and heating to 104°C and to 600°C. Both precipitates remained amorphous, except that ferric phosphate was identified after ignition at 600°C. (Selby-Texas)

W71-03457

**PHOSPHATE REMOVAL FROM WASTE WATERS USING LANTHANUM PRECIPITATION,**

Atomics International, Canoga Park, Calif.

Harold L. Recht, and Masood Ghassemi.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. 167, 13/4: 17010 EFX 04/70 paper copy \$0.75. Available from NTIS as PB-196 738, \$0.95 in microfiche. Water Pollution Control Research Series 17010 EFX: 04/70. Advanced Waste Treatment Research Laboratory, Cincinnati, Ohio, April 1970. 45 p, 18 fig, 1 tab, 11 ref. FWQA Program 17010 EFX, Contract 14-12-183.

**Descriptors:** \*Phosphates, \*Waste water treatment, Turbidity, Aluminum, Hydrogen ion concentration, \*Effluents, Chemical precipitation.

**Identifiers:** Phosphate removal, Secondary effluent, \*Lanthanum, \*Orthophosphates.

A parametric study was made of the removal of ortho- and polyphosphates from pure solutions and secondary effluent with La (III), and the results compared with those from similar tests with Al (III). The reactions of orthophosphate with both La (III) and Al (III), resulting in precipitate formation

and phosphate removal, were complete in less than 1 sec. La (III) showed a broader effective pH range and lower residual phosphate concentration and thus proved to be far superior to Al (III) for phosphate, especially polyphosphate, precipitation. Within the pH range for optimal phosphate removal, the La (III)-phosphate reactions produced large, settleable flocs. Immediately outside this range, poorly settling fine turbidity developed. At pH levels above this region, some residual turbidity was generally observed. No turbidity or precipitation was observed at very low pH levels. At constant pH, orthophosphate removal was directly proportional to the La (III) PO<sub>4</sub>-3 molar ratio, with complete removal at a ratio of approximately 0.9. This strongly suggests that orthophosphate removal with La (III) occurs solely through a chemical reaction and not through an adsorption process. With secondary effluent, as with pure solutions, lower residual phosphate resulted over a wider pH range with La (III) than with Al (III); no pH adjustment is needed for effective removal with La (III), while considerable amounts of acid or excess Al (III) are required to achieve the optimum pH of 6 for phosphate removal. (Selby-Texas)

W71-03458

**ULTIMATE DISPOSAL OF PHOSPHATE FROM WASTE WATER BY RECOVERY AS FERTILIZER,**

Grace (W. R.) and Co., Clarksville, Md.

Maria G. Dunseth, Murial L. Salutsky, Kenneth M. Ries, and Joseph J. Shapiro.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Price \$0.70. 167, 13/4: 170170 ESJ 01/70 paper copy \$0.70. Available from NTIS as PB-196 739, \$0.95 in microfiche. Water Pollution Control Research Series 170170 ESJ-01/70. Advanced Waste Treatment Research Laboratory, Cincinnati, Ohio, January 1970. 74 p, 24 tab, 18 fig, 13 ref. FWQA Program 17010 ESJ, Contract 14-12-171.

**Descriptors:** \*Phosphates, \*Waste water treatment, Fertilizers, Biochemical oxygen demand, Chemical oxygen demand, Effluents, Sewage effluents, \*Water reuse.

**Identifiers:** Digester supernatant, \*Orthophosphates.

Many of the proposed processes that reduce orthophosphate in the effluents from sewage treatment plants result in the extracted phosphate being concentrated in the digester supernatant. This phosphate must be removed prior to disposal of the supernatant or its recycle back to the head of the treatment plant. Digester supernatant was treated in two ways. The first was to add magnesia and elevate the pH to 9 to cause precipitation of the phosphorus. The other technique was to apply heat and/or vacuum to the digester supernatant which caused precipitation of the soluble orthophosphate. A 90% removal of orthophosphate can be achieved by either approach. The heat and/or vacuum process also yields a supernatant substantially lower in BOD, COD, and nitrogen concentration. The precipitated phosphorous (primarily a mixture of calcium phosphate and magnesium ammonium phosphate) was found available for plant food according to AOAC (i.e., Association of Official Agricultural Chemists) procedures. Work was conducted by bench and pilot plant studies on digester supernatant from the Lake Zurich, Illinois sewage treatment plant and from the Libertyville, Illinois sewage treatment plant. (Selby-Texas)

W71-03459

**INTERNAL HYDRAULICS OF THERMAL DISCHARGE DIFFUSERS, A DISCUSSION,**

Camp, Dresser and McKee, Boston, Mass.

Thomas R. Camp, and David S. Gruber.

Journal of the Hydraulics Division, Proceedings of the ASCE, Vol No HY12, December 1970, p 2631-2637. 4 fig, 1 tab, 4 ref.

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

Descriptors: \*Diffusion, \*Hydraulics, \*Pipe flow, \*Discharge coefficients, Thermal pollution, Reynolds number, Model studies.  
Identifiers: \*Friction factor, Diffusers, Spacing ratios.

An article about planning and design of outfalls for mixing both waste water effluents and cooling water with fresh water streams is discussed in this paper. It is said that the authors of the original article have presented a much simpler alternative computational procedure for the design of such dispersion conduits, based on an analysis in which the lateral outflow and head losses are assumed to be distributed continuously along the length of the conduit. It is also assumed that the flow is uniformly decreasing along the length of the diffuser and the friction factor is constant. It is concluded that: the method studied provides a convenient means for the preliminary design of fresh water diffusers and for final evaluation of proposed designs. For major diffuser structures particularly, for configurations saving a nonconstant value of  $C'$ , which is a discharge coefficient, the procedure would be essential for final evaluation. If the diffuser is to be used for varying flow conditions,  $m$ , the selected design ratio of discharge at the latter outlet to the discharge at the former outlet will change with discharge to a degree depending upon the change in  $f$  and  $C'$ . The accuracy required depends, on the accuracy to which  $m$  must be predicted, at being noted that  $m$  is relatively insensitive to changes in head loss if  $1-m$  is small. (Herrera-Venderbilt)  
W71-03461

HEATED SURFACE JET DISCHARGED INTO A FLOWING AMBIENT STREAM,  
Vanderbilt Univ., Nashville, Tenn. Dept. of Environmental and Water Resources Engineering.  
For primary bibliographic entry see Field 05B.  
W71-03478

#### ELECTRODIALYSIS IN ADVANCED WASTE TREATMENT, Ionics, Inc., Cambridge, Mass.

J. D. Smith, and J. L. Eisenmann.  
Available from NTIS as PB-174 925, \$3.00 in paper copy, \$0.95 in microfiche. Water Pollution Control Research Series WP-20-AWTR-18, Federal Water Pollution Control Administration, Robert A Taft Sanitary Engineering Center, Feb 1967. 219 p, 32 fig, 33 tab, 19 ref. FWPCA Project 17040--02/67.

Descriptors: \*Electrodialysis, \*Economics, Demineralization, Membranes, Scaling, Design, \*Waste water treatment.  
Identifiers: Deionization, Anion membranes.

To determine the practicality of partially demineralizing municipal waste water by electrodialysis, a bench-scale experiment was made, using filtration alone and filtration followed by carbon adsorption as pretreatments. Long-term runs were made with a municipal secondary effluent to determine scaling and fouling effects of the water upon the electrodialysis membranes. A study was made during these runs to determine how high a ratio of product rate to concentrate rate could be obtained without forming scale on the membranes. Some fouling of anion membranes occurred with filtration and carbon adsorption pretreatment; without carbon adsorption, fouling was much worse. Scale formation was not a problem at product to concentrate ratios less than ten. At times much higher ratios were obtained without difficulty. The results of these runs indicated that the total operating cost for a 10-mgd electrodialysis treatment plant might be less than \$.10 per 1,000 gal. (Selby-Texas)  
W71-03503

#### ELECTROCHEMICAL TREATMENT OF MUNICIPAL WASTE WATER, Pennsalt Chemicals Corp., Philadelphia, Pa. H. C. Miller, and W. Knipe.

Available from NTIS as PB-168 794, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-13, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Sanitary Engineering Center, March 1965. 58 p, 14 tab, 6 fig, 15 ref. FWPCA Project 17020--03/65.

Descriptors: \*Waste water treatment, \*Electrochemistry, \*Economics, Chemical oxygen demand, Activated sludge, Chlorides, Electrodes, Anodes, Alkylbenzene sulfonates, Municipal water.  
Identifiers: Lead, Lead-silver alloys, Lead dioxide, Municipal waste water.

The effectiveness of electrolytic methods of treating waste water is in doubt. This study shows that an electrolytic treatment of secondary effluent from an activated-sludge plant using lead dioxide anodes can reduce ABS by 90%, COD by 80%, and chloride by 90%. This treatment has little effect on total solids. The cost of treatment will vary between \$0.90 and \$2.42 per 1,000 gallons. The plant costs will vary between \$9 million and \$26 million for a 10 mgd plant. The method is not considered economically practical for waste water renovation, wherein waters of relatively low conductivity must be processed. The authors also conclude that the work by the Lead Industries Association on the use of lead and lead-silver alloys in the treatment of waste waters should be followed since the results may have application in treating waste waters of relatively high conductivity. (Selby-Texas)  
W71-03504

#### ADSORPTION OF BIOCHEMICALLY RESISTANT MATERIALS FROM SOLUTION 1, Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.

J. C. Morris, and W. J. Weber, Jr.  
Available from NTIS as PB-168 799, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-9, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Sanitary Engineering Center, May 1964. 74 p, 40 fig, 7 tab, 16 ref. FWPCA Project 17020--05/64.

Descriptors: \*Waste water treatment, \*Adsorption, Activated carbon, Kinetics, Equilibrium.  
Identifiers: Advanced waste treatment, Refractory materials.

The report is primarily a summary of research progress rather than a complete description of how adsorption may be used to optimum advantage. The studies on the kinetics of adsorption on granular carbon showed that: (1) Uptake from dilute solution proceeds slowly for compounds of high molecular weight, (2) The rate of adsorption is a linear function of the square root of concentration. This implies that the process favors removal of trace quantities, (3) Rates of adsorption decrease considerably with increasing size of adsorbate when the amount adsorbed per unit is expressed in molar units; when expressed in weight units, the effect is much less pronounced, (4) The configuration of the adsorbate molecule affects rate of uptake; molecules with highly branched structures are removed much more slowly than those of identical molecular weight but with a configuration that permits coiling or attainment of compactness, (5) Rates of adsorption per unit weight of carbon vary reciprocally as the square of the diameter of individual carbon particles, (6) The rate of adsorption of alkylbenzenesulfonates increases with decreasing pH of the solution. The findings correlate with equations derived for infarparticle diffusion, which indicates that the rate of adsorption is controlled by rate of diffusion of solute within the micropores of the carbon. Extension of this research, currently underway, should provide supplementary information that will be of considerable use in the final design of appropriate adsorption processes. (Selby-Texas)  
W71-03505

#### ADSORPTION OF BIOCHEMICALLY RESISTANT MATERIALS FROM SOLUTION 2, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

J. C. Morris, and W. J. Weber.

Available from NTIS as PB-170 700, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-16, Advanced Waste Treatment Program, Federal Water Pollution Control Administration, Robert A Taft Sanitary Engineering Center, March 1966. 108 p, 77 fig, 13 tab, 37 ref, 2 app. FWPCA Project 17020--03/66.

Descriptors: \*Adsorption, \*Activated carbon, Waste water treatment, Equilibrium, Kinetics, Pesticides.

Identifiers: Refractory materials, Regeneration, Advanced waste treatment.

As reported in PHS Publication No 999-WP-11-AWTR-9, earlier studies showed that activated carbon for waste water renovation could best be used in continuous-flow columns. Such techniques should result in an adsorptive capacity of greater than 10%. Results on studies of adsorption of organics from single-and multi-component systems in fluidized carbon are reported in these publications. The adsorbability of organic pesticides on activated carbon was investigated in some detail. Studies were undertaken to characterize those types of organic pollutants that are not adsorbed on activated carbon. The report concludes that if additional removal of organic matter beyond that now obtainable with reasonable depth of activated carbon is desired, one should follow the activated carbon with a contrasting type of adsorbent. (Selby-Texas)  
W71-03506

#### FEASIBILITY OF GRANULAR ACTIVATED CARBON ADSORPTION FOR WASTE-WATER RENOVATION,

Pittsburgh Chemical Co., Pa.

R. S. Joyce, and V. A. Sukenik.  
Available from NTIS as PB-169 383, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-18, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Sanitary Engineering Center, Oct 1965. 38 p, 17 fig, 10 tab, 2 ref. FWPCA Project 17020--10/65.

Descriptors: \*Waste water treatment, \*Activated carbon, \*Adsorption, Flocculation, Chemical oxygen demand, Effluents, Sludge.

In the first interim report (AWTR-10, PHS Publication No. 999-WP-12) it was shown that treatment of secondary waste water effluent from an activated-sludge process with granular activated carbon in a column process reduced COD content to concentrations between 12 and 20 ppm. ABS removal was essentially complete. The current study was initiated to determine if an increased contact time in the carbon bed, effected by a reduction in flow rate, would improve the degree of COD removal. In the study, granular activated carbon in packed-bed column contractors 20 feet deep and operated at a flow rate of 4 gpm per square foot reduced the COD to an average value of 18.5 ppm. This was not significantly different from removal obtained at a 10 gpm per square foot operating level. Typical adsorption isotherms for type SGL carbon for COD indicated capacities of approximately 35% by weight. Cyclic saturation and regeneration of activated carbon through 16 cycles had an average carbon loss of 4.6% of secondary effluent prior to carbon adsorption increased the adsorption capacity of carbon and resulted in much lower final levels of COD than the levels obtained with unflocculated effluent. (Selby-Texas)  
W71-03507

#### EVALUATION OF VARIOUS ADSORBENTS AND COAGULANTS FOR WASTE WATER RENOVATION,

Ionac Chemical Co., Birmingham, N.J.

J. N. Williamson, A. H. Heit, and C. Calmon.

## Waste Treatment Processes—Group 5D

Available from NTIS as PB-170 741, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-12, Advanced Waste Treatment Research Program, Robert A Taft Sanitary Engineering Center, Public Health Service, June 1964. 91 p, 20 tab, 9 fig, 10 ref, append. FWPCA Project 17020--06/64.

Descriptors: \*Waste water treatment, Proteins, Anion exchange, Coagulation, Economics, Adsorption.

Identifiers: Minerals, Sludge blanket.

Certain inexpensive, commercially available materials were investigated to see if they hold promise in treatment of waste waters, especially secondary effluents. Activated carbon was used as a reference. Minerals treated with salts of tetravalent metals show promise for the organic-soluble phase of secondary waste water effluents. Most conventional coagulants exhibit marked affinities for the refractory organic materials in these secondary effluent. Proteins show similar properties when coagulated in the presence of mineral acids and certain acid salts of trivalent metals. Hydrophobic proteins, aldehyde hardened in granular shape then further reacted with acids or acid salts, will also remove organic refractory contaminants from secondary effluents. Organic anion exchangers will also remove organic solutes from waste water. The problem of irreversible organic fouling requires more attention if exchangers are to be considered. Precoagulation of the higher molecular species of organics is suggested as a fouling preventive measure. This study demonstrated the mechanical feasibility of incorporating solid adsorbents into the sludge blanket process for water treatment in the presence or absence of coagulants. The sludge blanket process can combine the virtues of finely divided, large surface area forms of solids and flocs with the maintenance of relatively high flow rates, normally associated with columnar-bed techniques. Material cost factors are discussed for the various materials tested and for the treatments involving their use. Recommendations are made for possible further lines of investigation. (Selby-Texas)

W71-03508

#### ADVANCED WASTE TREATMENT BY DISTILLATION,

Badger (W. L.) Associates, Inc., Ann Arbor, Mich.

J. H. Neale.

Available from NTIS as PB-168 839, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-7, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Engineering Center, March 1964. 55 p, 8 fig, 12 tab, 4 ref. FWPCA Project 17080-03/64.

Descriptors: \*Waste water treatment, \*Distillation, Evaporation, Economics, \*Scaling, \*Corrosion. Identifiers: \*Advanced waste treatment.

In a desk-top study of scaling and corrosion effects, a municipal water re-use cycle was assumed in which sufficient waste water distillate would be mixed with waste water treated for organic contaminant removal only to give a mixture suitable for the municipal water supply. The study shows that the concentration of scaling materials is small enough that, in many cases, distillation at a temperature of 400°F should be possible. An economic advantage over sea-water distillation would be expected. Potential corrosion problems exist. Continuous boiling experiments were carried out on Ann Arbor sewage to determine the fouling effects of organic contaminants. Distillation of secondary effluent at temperatures up to 250°F should not result in fouling. Operation with primary effluent does not appear feasible without additional treatment for removal of suspended materials. The study concluded that (1) distillation appears to be practical and economically attractive, (2) a system combining distillation and adsorption could be used to produce water for direct reuse, (3) pretreatment required for scale control prior to

distillation will vary, (4) cost of waste water renovation by distillation will be less than the cost of sea-water conversion, (5) distillation should be used in parallel with another, less expensive operation such as adsorption to achieve the lowest cost of product water, and (6) study of the application of distillation to advanced waste treatment should be continued, and a pilot study should be instituted. (Selby-Texas)

W71-03509

#### COST OF PURIFYING MUNICIPAL WASTE WATERS BY DISTILLATION,

Delaware Univ., Dover.

J. A. Gerster.

Available from NTIS as PB-168 978, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-6, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Sanitary Engineering Center, November 1963. 43 p, 10 tab, 6 fig, 36 ref. FWPCA Project 17080-11/63.

Descriptors: \*Waste water treatment, \*Distillation, \*Costs, \*Sea water, \*Flash distillation, Municipal water.

Identifiers: Multi-stage flash equipment, Multiple-effect equipment, Recompression-flash equipment, Municipal waste water, Blowdown.

To estimate the cost of distillation of waste water, desk top studies were made with the types of equipment proposed for use with sea water. The estimates are based upon those for sea water, but are modified to conform with the differences in the modes of operation for the two feeds. The smaller concentration of scaling materials in waste water should allow distillation to be carried out at a higher temperature than can be used with sea water. The smaller total contaminant concentration results in a smaller boiling-point elevation. Because of the need to dispose of the blowdown permanently it is necessary to concentrate to a far greater extent than in the case of sea-water distillation. Three types of equipment—multi-stage flash, multiple-effect, and recompression flash—appear economically promising. For all types of equipment the cost for the distillation step alone is somewhat less than for sea water, but inclusion of costs for feed pretreatment and ultimate disposal of blowdown, bring the cost up to about that for sea water. (Selby-Texas)

W71-03510

#### CONTAMINANT REMOVAL FROM SEWAGE PLANT EFFLUENTS BY FOAMING,

Radiation Applications, Inc., Long Island City, N.Y.

E. Rubin, R. Everett, Jr., and J. J. Weinstock.

Available from NTIS as PB-168 797, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-5, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Engineering Center, Cincinnati, Ohio, December 1963. 56 p, 17 tab, 12 fig, 22 ref. FWPCA Project 17020-12/63.

Descriptors: \*Waste water treatment, \*Foaming, \*Alkylbenzene sulfonates, Chemical oxygen demand, Sewage effluents, Detergents.

Identifiers: Volume reduction, Advanced waste treatment.

One of the refractory solutes present in most sewage plant effluents is the surface-active agent alkyl benzene sulfonate (ABS). The paper reports that ABS concentrations (based on methylene blue analysis) between 2.0 and 3.2 ppm in secondary effluent have been consistently reduced to between 0.3 and 0.5 ppm by use of air-to secondary effluent, volumetric-flow ratios between 7 and 3, correspondingly. A correlation has been demonstrated between residual ABS concentration and the volume of aeration air available per unit mass of ABS in secondary effluent. A 10 to 45% diminution in COD was observed after foaming. Volume reductions in continuous equipment averaged

about 125, and values up to 1,000 have been obtained. Total dissolved solids and chloride ions have been found to be unaffected by the foaming process. An increase in pH upon foaming suggests that weakly acidic substances are being removed. (Selby-Texas)

W71-03511

#### PART 1. A DESIGN STUDY OF FREEZING AND GAS HYDRATE FORMATION. PART 2. FEASIBILITY TESTS OF FREEZING,

Syracuse Univ., N.Y.

A. J. Barduhn, A. Rose, and R. F. Sweeny.

Available from NTIS as PB-168 798, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-4, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Sanitary Engineering Center, October 1963. 45 p, 10 tab, 8 fig, 19 ref. FWPCA Project 17080-10/63.

Descriptors: \*Waste water treatment, \*Freezing, Economics, Pre-treatment (Water), Chemical oxygen demand, Alkyl benzene sulfonate, Sea water, Municipal waste.

Identifiers: \*Advanced waste treatment, \*Gas hydration.

In a preliminary design to renovate municipal waste waters, freezing and gas hydrate processes for demineralizing sea water are adapted. The author of part one, assuming a feed material containing 1,000 parts total dissolved solids per million, predicts costs for recovering 92% of the feed as potable water. The waste stream can be further concentrated under eutectic conditions to produce more water and a waste stream of damp solids. In part 2, during 14 actual freezing tests completed, chemical oxygen demand was reduced 65 to 85%; chlorides 85 to 90%; and conductivity, 90% or more. Reduction of alkyl benzene sulfonate was erratic. With data from the better test runs, preliminary cost estimates indicate that 95% of the feed water containing 10% of the contaminants can be recovered at a cost somewhat lower than that predicted for desalinating sea water by freezing. (Selby-Texas)

W71-03512

#### ULTIMATE DISPOSAL OF ADVANCED-TREATMENT WASTE, PART 1. INJECTION, PART 2. PLACEMENT IN UNDERGROUND CAVITIES, PART 3. SPREADING,

Louis Koenig-Research, San Antonio, Tex.

For primary bibliographic entry see Field 05E.

W71-03513

#### ULTIMATE DISPOSAL OF ADVANCED-TREATMENT WASTE, PART 1. WET OXIDATION, PART 2. INCINERATION,

Louis Koenig-Research, San Antonio, Tex.

For primary bibliographic entry see Field 05E.

W71-03514

#### SUMMARY REPORT, ADVANCED WASTE TREATMENT, JULY 1964-July 1967.

Federal Water Pollution Control Administration, Cincinnati, Ohio.

Available from NTIS as PB-179 515, \$3.00 in paper copy, \$0.95 in microfiche. Water Pollution Control Research Series WP-20-AWTR-19, Advanced Waste Treatment Branch Division of Research, Robert A Taft Engineering Center, 1968. 96 p, 17 tab, 36 fig, 24 ref, append. FWPCA Project 17000-07/68.

Descriptors: \*Waste water treatment, Nutrients, Lime, Ultimate disposal, Activated carbon, Electrodialysis, Ion exchange, Reverse osmosis, Denitrification, Electrochemistry, Foaming, Solvent extraction, Distillation, Freezing.

Identifiers: \*Advanced waste treatment, \*Lime clarification, Suspended solids removal, Organic removal, Inorganic removal, Nutrient removal, Granular carbon, Powdered carbon, Air stripping.

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

The report summarizes results of advanced waste-treatment studies from July 1964 to July 1967. A wide range of waste water treatment processes have been evaluated under the program for technical and economic feasibility. These methods include processes for suspended solids removal, organic and inorganic removal, nutrient removal, and ultimate disposal of concentrated end products. A number of processes have been studied extensively enough to assess their feasibility to a fair degree of accuracy. For waste waters, with appropriate contaminant composition, lime clarification will effectively remove suspended solids and the nutrient phosphate and the economics are expected to be favorable. Alum clarification is expected to be a successful method at a cost of 8 cents/1,000 gal. or less for a 10-mgd plant. For organic removal, activated-carbon treatment is very promising. Granular-carbon treatment without clarification of the feed can be carried out for about 8 cents/1,000 gal. at the 10-mgd level. Powdered-carbon treatment should cost about 12 cents/1,000 gal. at the 10-mgd level, provided carbon can be reactivated, with process improvements probably reducing the costs. For removal of gross inorganic content, electrodialysis should be possible for about 16 cents/1,000 gal in a 10-mgd plant. Other inorganic removal processes such as ion exchange and reverse osmosis may be competitive with electrodialysis. An air-stripping process for ammonia appears technically feasible and should not cost over 2 cents/1,000 gal for a 10-mgd plant, excluding cost of adjustment of pH to 10 or above. Initial study of denitrification of a highly nitrified effluent or granular activated carbon shows promise for nitrate removal. Study of a number of processes given preliminary evaluation has been halted for the present because of certain unfavorable characteristics. These processes include electrochemical treatment, foaming, solvent extraction, distillation and freezing. (Selby-Texas) W71-03515

#### SUMMARY REPORT-THE ADVANCES WASTE TREATMENT RESEARCH PROGRAM-JUNE 1960-DECEMBER 1961.

Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.

Available from NTIS as PB-174 923, \$3.00 in paper copy, \$0.95 in microfiche. Public Health Service, Robert A. Taft Sanitary Engineering Center, Summary Report, (June 1960-Dec 1961) ec TR, W62-9, May 1962. 65 p, 34 ref. FWPCA Project 17000-95/62.

Descriptors: \*Waste water treatment, \*Research and development, Economics.

Identifiers: Extramural and intramural research, Challenge, Organization and administration.

The first section discusses the containments of challenge; the second the economic challenge; the third the technical approaches being explored; the fourth the organization and administration of the program; and the fifth the present status of both extramural and intramural research efforts. (Selby-Texas) W71-03516

#### REMOVAL OF PHOSPHATES BY SORPTION ON ACTIVATED ALUMINA,

Missouri Water Resources Research Center, Columbia.

Krishnier Purushothaman, and C. M. Yue.

Available from NTIS as PB-196 872, \$3.00 in paper copy, \$0.95 in microfiche. Completion Report, Missouri Water Resources Research Center, December 30, 1970. 79 p, 7 tab, 26 fig, 31 ref. OWRR Project A-029-MO(1).

Descriptors: \*Phosphates, \*Sorption, \*Activated alumina, \*Eutrophication, Tertiary treatment, Waste water treatment, Water pollution effects, Ions.

Identifiers: Alcoa alumina, \*Freundlich equation, \*Phosphorous removal, Ion removal.

The purpose of this investigation was to study the removal of phosphorus from waste water by sorption on activated alumina, and determine the capacity of the alumina to sorb phosphates in the presence of other ions, the effect of the influent flow rate and phosphorus concentration on the efficiency of the process, and the feasibility of regeneration of the used alumina. The studies were conducted using deionized and tap water to which inorganic phosphate had been added, and secondary effluent from bench-scale activated sludge units. They involved batch tests employing three types of activated alumina, ALCOA XM (minus 325 mesh), F-1 (minus 100 mesh), and F-1 (28-48 mesh), and continuous-flow tests carried out in three specially designed glass sorption columns using the F-1 (28-48) alumina. Activated alumina was found to have a greater capacity for removing phosphorus in the presence of hardness-causing ions, and each type of alumina had a different capacity for each test water used. The fraction of phosphorus removed by each alumina decreased when the initial phosphorus concentration in the test water increased. The influent flow rate inversely affected the phosphorus loading capacity of the alumina, and the used aluminas could be effectively regenerated with a 2M sodium hydroxide solution alone.

W71-03518

#### PAB PROCESS FOR ADVANCED WASTE TREATMENT,

Iowa State Univ., Ames. Engineering Research Institute.

Robert L. Johnson, and E. Robert Baumann. Available from NTIS as PB-196 146, \$3.00 in paper copy, \$0.95 in microfiche. Iowa State Water Resources Research Institute, Completion Report, ISU-ERI-AMES-91100, ERI Project 756-S, December 1970. 42 p, 11 tab, 11 fig, 20 ref. OWRR Project A-025-IA (2).

Descriptors: \*Adsorption, \*Refractivity, \*Tertiary treatment, \*Waste water treatment, Effluents, Sewage effluents, Organic wastes.

Identifiers: Refractory organics, Pulsed adsorption bed, Total organic carbon, Biological metabolism, \*Organic waste removal.

A NEW TERTIARY TREATMENT PROCESS HAS BEEN DEVELOPED UTILIZING THE PHYSICAL-CHEMICAL ADSORPTION OF SOLUBLE AND COLLOIDAL ORGANIC MATERIAL IN THE DILUTE FINAL EFFLUENTS OF SECONDARY BIOLOGICAL PROCESSES ONTO GRANULAR MEDIA. The refractory organic material thus concentrated can be utilized by microorganisms growing at the interface of the media in the pseudo-high concentration substrate. A significantly greater biological oxidation and synthesis of the residual organic material in the waste water is thus achieved and the interface is continuously regenerated. The waste water and air flow co-currently upward through a media bed. The air provides oxygen for biological activity and agitation of the media bed to prevent clogging. The rising air bubbles impact a periodic or pulsed motion to the media bed. Thus, the process was named the PULSED ADSORPTION BED (or PAB) PROCESS. The PAB process was developed first on a laboratory scale using synthetic sewage, and then with a pilot plant using trickling filter plant final effluent. Hydraulic loading rates of 125 and 220 MGAD were used in the laboratory and up to 100 MGAD in the field operation of the pilot plant. Corresponding organic loading rates were approximately 300 pounds BOD/1000 cubic feet/day. The PAB process coupled with solids separation units such as mixed media filters can provide 70 to 90 percent removal of the organic material in the final effluent from conventional complete treatment facilities. A combined solids treatment system could be designed, constructed and operated at a total annual cost of approximately 4 cents/1000 gallons.

W71-03519

#### MANPOWER SUPPLY IN WASTE WATER TREATMENT PLANTS,

Purdue Univ., Lafayette, Ind. Water Resources Research Inst.

L. N. Smith, and W. L. Miller.

Available from NTIS as PB-196 875, \$3.00 in paper copy, \$0.95 in microfiche. Purdue University Water Resources Research Center Technical Report No. 15, August 1970. 90 p, 1 fig, 15 tab, 22 ref. OWRR Project A-011-IND (1).

Descriptors: \*Manpower, Employment opportunities, \*Labor supply, Occupations, Resource allocations, \*Waste water treatment, Wages.

Identifiers: Waste water treatment plant operators.

The research attempts to answer the question whether enough trained men will be available who are willing to work in the waste water treatment industry under present and projected economic conditions. The quantity of waste water treatment plant operators was postulated to be a function of wages, alternative wages, population, unemployment, and recent hirings. Simple equation, linear regression procedures based on cross sectional data, were used to estimate the operator supply functions. The analysis concludes that two variables appear to be significant in explaining the quantity of operators supplied, that is, wages and population. Projections for two regions in Indiana and for the State as a whole were made for 1972. The conclusions suggest managers have several alternatives to insure enough skilled and trained operators will be available. These alternatives include the change in wages and population variables suggested by the analysis of the supply function in this study and other techniques, such as, employing one operator full time to service a few small plants in the same geographic area or the training of additional operators. (Wiersma-Purdue) W71-03521

#### MEMBRANE FOULING AND STUDIES ON NEW ELECTRODIALYSIS MEMBRANES,

Negev Inst. for Arid Zone Research, Beersheba (Israel).

For primary bibliographic entry see Field 03A.

W71-03522

#### REPORT ON WATER AND WASTE WATER FOR BROWARD COUNTY, FLORIDA.

Affiliates of Florida, Inc., Miami. Broward County Area Planning Board, Fort Lauderdale, Fla.

Available from NTIS as PB-195 039, \$3.00 in paper copy, \$0.95 in microfiche. Broward County Area Planning Board, Fort Lauderdale, Feb 1970. 256 p, 37 fig, 25 tab. HUD Project Fla P-85.

Identifiers: \*Regional planning, \*Florida, \*Water resources, Regional planning, Water pollution, Sewers, Financial management, Waste water, Water treatment, \*Broward County, Florida.

The report presents the recommendations resulting from a comprehensive water and waste water study. The study is addressed to existing conditions; adequacy of water and waste water facilities for present and future requirements; presentation of recommendations for future wholesale water and sewerage service, with attendant financing and administrative requirements. W71-03532

#### HOUSE FLY PUPAE AS FOOD FOR POULTRY,

Agricultural Research Service, Beltsville, Md.

C. C. Calvert, R. D. Martin, and N. O. Morgan.

Journal of Economic Entomology, Vol 62, No 4, p 938-939, 1970. 2 tab, 2 ref.

Descriptors: \*Poultry, Farm wastes, Feeds, Nutrients, Larvae, Waste treatment.

Identifiers: \*House fly, Musca domestica L., Fly pupae.

Investigations were made to determine whether larvae or pupae of the house fly contained sufficient

nutrient value to use as feed for growing chicks. The results demonstrated that dried fly pupae provided enough protein of sufficient quality to support normal growth of chicks during the first two weeks of life. (Christenbury-Iowa State) W71-03533

#### DANGEROUS GASES IN AGRICULTURE.

Ministry of Agriculture, Fisheries and Food, London (England).

Agriculture, Vol 77, No 9, p 431-432, September 1970.

Descriptors: \*Gases, Farm wastes, Storage pits, Slurries, Accidents, Waste treatment.  
Identifiers: Bacterial decomposition.

Gases from slurry pits can be dangerous to animals and concentrations fatal to man can occur. During storage and bacterial decomposition of the slurry causes a breakdown in organic matter and the release of gases. Recommendations are given that should help prevent accidents. (Christenbury-Iowa State)  
W71-03534

#### FATTY ACID CONTENT AS A MEASURE OF THE ODOUR POTENTIAL OF STORED LIQUID POULTRY MANURE,

Guelph Univ. (Ontario). Dept. of Microbiology.  
For primary bibliographic entry see Field 05A.  
W71-03535

#### FLOW PROPERTIES OF ANIMAL WASTE SLURRIES,

Pennsylvania State Univ., University Park.  
Mahesh Kumar, H. D. Bartlett, and N. N. Mohsenin.

Paper presented at the 1970 winter meeting American Society of Agricultural Engineers, Chicago, Dec 8-11, 1970, Paper No 70-911. 28 p, 7 fig, 2 tab, 26 ref.

Descriptors: \*Slurries, \*Viscosity, \*Viscometers, Farm wastes, Viscous flow, Temperature, \*Flow characteristics, Moisture content, Shear strength.  
Identifiers: Shear diagrams, Flow behavior indices, Dilution, Pseudoplastic flow, Apparent viscosities, Newtonian fluids, Total solids.

The flow properties of animal waste slurries were studied with the use of a coaxial cylinder-type viscometer to determine shear diagrams, flow behavior indices, viscosity indices and apparent viscosities in relation to dilution, temperature and sawdust bedding content of the slurries. The viscosity of manure slurry decreases with increase in dilution. Flow is Newtonian for total solid content below five per cent. Addition of sawdust decreases the viscosity of slurries. Viscosity of fresh manure decreases with increase of temperature. Manure slurry of four to six percent total solids content is a good compromise between excessive volume of handling and power requirement. (Christenbury-Iowa State)  
W71-03541

#### RELATIONSHIP OF AGRICULTURE TO SOIL AND WATER POLLUTION.

Cornell Univ., Ithaca, N.Y.  
For primary bibliographic entry see Field 05B.  
W71-03542

#### POLLUTION FACTORS ASSOCIATED WITH EXCESSIVE POULTRY LITTER (MANURE) APPLICATION IN ARKANSAS,

Arkansas Univ., Fayetteville. Dept. of Agronomy.  
For primary bibliographic entry see Field 05C.  
W71-03544

#### REDUCING THE POLLUTION POTENTIAL OF LIVESTOCK WASTES WITH IN-THE-BUILDING OXIDATION DITCHES,

Cornell Univ., Ithaca, N.Y. Dept. of Agricultural Engineering.  
D. L. Day.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 77-84. 11 fig, 3 ref.

Descriptors: \*Farm wastes, Oxidation lagoon, Irrigation, Aeration, Biochemical oxygen demand, Odor, Aerobic treatment, Labor, Rotors, Denitrification, Coagulation, Effluent.  
Identifiers: \*Oxidation ditch, \*Slotted floors, Aerator, Clarifier.

A low-odor, low-labor, system of managing livestock wastes from animal to field is discussed. The system consists of (1) a confinement building for livestock, with self-cleaning, slotted floors; (2) an oxidation ditch beneath the slotted floors; (3) a nonoverflow of mixed liquor from the oxidation ditch; and (4) irrigating equipment for removing surplus liquids and solids from the lagoon and distributing them on nearby land when convenient for the operator. This system greatly improves the quality of the waste water, but without further treatment the waste water would probably not meet quality criteria for the receiving water. Thus the main advantages of the system are: low labor, low odor, low stream-pollution potential, and operator convenience. (See also W71-03542) (White-Iowa State)  
W71-03545

#### THE CONCEPTUAL DESIGN OF AN ECONOMICALLY FEASIBLE ANIMAL WASTE DISPOSAL SCHEME,

Resource Engineering Associates, Wilton, Conn.  
R. W. Okey, and R. N. Rickles.

In: Relationship of Agriculture To Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 85-97. 11 tab, 4 fig, 11 ref.

Descriptors: \*Farm wastes, \*Cattle, \*Biological treatment, Treatment facilities, Capital costs, Operating costs, Installation costs, Sludge, Centrifugation, Denitrification, Phosphorus, Nitrogen, Incineration, Biochemical oxygen demand, Chemical oxygen demand.  
Identifiers: \*Feedlot, Population equivalent, Waste management, Clarifier, Transport system.

Based on earlier work, a complete system for the capture, transport and treatment of the wastes from a 25,000 animal lot was presented. System capital costs are seen to be about \$1.00 - \$2.00/ton, and operating costs are around \$3.00 - \$4.00 per ton of wet waste. These costs result in a cost/lb gained of less than half a cent to about a cent. The costs for the least expensive system are an order of magnitude below feed costs. The installation costs are in the order of \$15.00 to \$40.00/animal or less than the capital cost as the least expensive confinement scheme. Economic feasibility is a combination of many things. One of the most important is the relevance of a particular item when all the costs are considered. The costs of waste treatment at feedlots would appear to represent roughly the same fraction of the total costs as seen in other industries. (See also W71-03542) (White-Iowa State)  
W71-03546

#### THE ECONOMICS OF STORING, HANDLING AND SPREADING OF LIQUID HOG MANURE FOR CONFINED FEEDER HOG ENTERPRISES,

M. F. McKenna, and J. H. Clark.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 98-110. 12 tab.

Descriptors: \*Farm wastes, \*Hogs, \*Storage capacity, Chemical analysis, Fertilizers, Storage tanks, Value, Soil contamination, Nitrogen, Phosphorus, Potassium, Nutrient requirements, Linear programming.  
Identifiers: \*Spreading, Seasonal application, Disposal costs.

The main hypothesis made at the outset of the study, that the economically optimal storage capacity would be affected by the density of hogs per acre and the crops under cultivation on the farm was supported. Of these two factors it was found that the ratio of hogs per acre was the more significant. For a spreading operation with the relatively high fixed costs associated with spreading, farms with smaller herd sizes were seen to encounter significantly higher spreading costs per hog than farms with larger herds. In some cases the extent of these costs will be sufficient to cancel out the positive value of the manure as a replacement for commercial fertilizer. It would therefore appear that significant savings might be realized if hog operators were to enter rental or custom arrangements for manure spreading. The overall conclusion reached in the study was that for Ontario conditions a land utilization program for the liquid manure supply does represent an economic means of handling the animal waste management problem. (See also W71-03542) (White-Iowa State)  
W71-03547

#### LAND DISPOSAL OF DAIRY FARM WASTE,

Florida Univ., Gainesville. Dept of Agricultural Engineering.

A. R. Overman, C. C. Hortenstine, and J. M. Wing.  
In: Relationship of Agriculture To Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 123-126. 3 fig, 2 ref.

Descriptors: \*Farm wastes, \*Cattle, Dairy industry, Effluent, Nitrogen, Phosphates, Soil contamination, Groundwater, Water pollution, Florida, Sprinkler irrigation, Rates of application, Nitrate, Oats, Waste disposal.  
Identifiers: \*Dairy cattle, Land disposal.

Wastes from 160 cows in a new milking barn at the University of Florida are collected in a 20,000-gallon holding tank and removed daily. An open impeller pump is used to deliver effluent to sprinkler guns which apply 1/4, 1/2, and 1 inch per week. The plots were seeded to oats, with no mineral fertilizer added. Measurements were taken to determine effectiveness of the oats in utilizing nutrients. Groundwater samples were extracted weekly at depths of 30, 45, and 60 cm. for chemical analysis. Results are reported for nitrate and orthophosphate content. It is concluded that the soil plant system can be effective in renovation of waste water farm animal operations. Removal of nitrogen and phosphorus is greatly enhanced by plant growth. Nutrient removal was found adequate up to an application rate of 1 inch per week effluent with solids content of about 0.115 percent. It appears that a more intense application rate could be used. (See also W71-03542) (White-Iowa State)  
W71-03548

#### NITROGEN TRANSFORMATIONS AND PLANT GROWTH AS AFFECTED BY APPLYING LARGE AMOUNTS OF CATTLE FEEDLOT WASTES TO SOIL,

Southwestern Great Plains Research Center, Bushland, Tex.

A. C. Mathers, and B. A. Stewart.  
In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 207-214. 8 fig, 2 tab, 3 ref.

Descriptors: \*Farm wastes, \*Cattle, \*Nitrification, Denitrification, Nitrate, Nitrogen, Ammonia, Carbon dioxide, Greenhouses, Laboratories, Carbon,

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

Rates of application, Incubation, Phosphorus, Potassium.  
Identifiers: \*Feedlots, \*Nitrogen transformations, Pullman silty clay loam, Yield.

The objectives of these studies were: (1) to determine the decomposition rates and nitrogen transformations of animal wastes when applied to soil at various rates; and (2) to study the effects on plant growth of applying large amounts of animal wastes to soil. Studies were carried out with 0, 1, 2.5, 5, 10, and 20% rates of cattle feedlot waste added to Pullman silty clay loam in both laboratory and greenhouse tests. Three conclusions were reached: (1) When feedlot waste was mixed with soil, evolution of C and transformation of N were rapid. In 90 days, about 50% of the C was evolved as CO<sub>2</sub> and an equivalent amount of N was recovered as NH<sub>3</sub> evolved, or as NH<sub>4</sub><sup>+</sup> and NO<sub>3</sub><sup>-</sup> in the soil. (2) Nitrification was influenced by application rate of manure and moisture content of the soil during incubation. (3) In a greenhouse study, one unit of N from ammonium nitrate was equivalent to 2.4 units of N supplied in feedlot waste. (See also W71-03542) (White-Iowa State)  
W71-03550

#### RATES OF WATER INFILTRATION RESULTING FROM APPLICATIONS OF DAIRY MANURE,

Cornell Univ., Ithaca, N.Y. Dept. of Agronomy.  
For primary bibliographic entry see Field 04C.  
W71-03554

#### POULTRY POLLUTION: PROBLEMS AND SOLUTIONS.

Michigan Agricultural Experiment Station, East Lansing.

Research Report 117, Farm Science, July 1970. 55 pages.

Descriptors: \*Farm wastes, \*Poultry, \*Dehydration, Eggs, Nitrogen, Diets, Feeds, Odor, Water pollution, Air pollution, Soil contamination, Disease, Insects, Standards, Land use, Septic tanks, Sludge disposal, Digestion, Ventilation, Rates of application, Corn, Nitrate, Chemical properties, Drying, Moisture content, Nutrients, Taste.  
Identifiers: Environmental quality, Indoor lagoons, Laying hens, Feed conversion, Egg production, Dehydrated poultry waste, Feed efficiency.

The report contains eleven articles with an introduction and a table compilation of properties of poultry waste that were analyzed. Reports on indoor septic handling of poultry manure and effect of application rate of chicken manure on corn yields are presented. A large part of the report deals with drying and feeding poultry manure to laying hens. Results of feeding dehydrated poultry waste to laying hens and its effect on egg production, feed conversion, body weight, egg weight, shell thickness, Haugh score, egg taste, and quality changes during storage are presented. Acceptability and digestibility of poultry and dairy wastes by sheep is also reported. Bacteriological procedures and current research being carried out at Michigan State University conclude the report. (See also W71-03556 thru W71-03564) (White-Iowa State)  
W71-03555

#### POULTRY MANURE HANDLING BY INDOOR SEPTIC TANKS (SO-CALLED 'INDOOR LAGOONS'),

Michigan State Univ., East Lansing. Dept. of Poultry Science.

J. A. Davidson, and C. J. Mackson.

In: Research Report 117, Farm Science, MSU Agricultural Experiment Station, July 1970, p 8-9.

Descriptors: \*Farm wastes, \*Poultry, \*Septic tanks, \*Sludge, Sludge disposal, Digestion, Odor, Ventilation.  
Identifiers: \*Indoor lagoons, Laying hens, Compressed air agitation, Paddle wheel agitation, Floor space.

The report details the use of shallow water filled tanks for the disposal of poultry manure. The experiment was carried on for 5 years, during which time several variations were used. The original experiment consisted of a tank 10' x 24' x 2' deep in a pen 20' x 24'. The tank was filled with 18" of water and all droppings were caught in the tank. The second year, compressed air was used to agitate the material. Approximately 9 inches of sludge was cleaned out after 11 months of operation. Flies were no problem. Successive experiments used different amounts and methods of agitation. Each year the sludge accumulation was cleaned out with a septic tank service truck. Indoor septic tanks (indoor lagoons) covering 1/2 the floor space can handle the droppings from 300 laying hens for at least 11 months. This means one annual cleaning. This method could be used in cage operations. (See also W71-03555) (White-Iowa State)  
W71-03557

#### THE EFFECT OF APPLICATION RATE OF CHICKEN MANURE ON THE YIELD OF CORN,

Michigan State Univ., East Lansing. Dept. of Poultry Science.

L. S. Robertson, and John Wolford.

In: Research Report 117, Farm Science, MSU Agricultural Experiment Station, July 1970, p 10-15. 4 tab.

Descriptors: \*Farm wastes, \*Poultry, \*Chemical properties, \*Rates of application, Hydrogen ion concentration, Phosphorus, Potassium, Soil tests, Corn, Crop production, Michigan, Nitrate, Magnesium, Carbon.  
Identifiers: \*Plant food content, Huron County Michigan.

The report begins by giving an indication of the magnitude of the poultry manure problem in Michigan. Tables showing the chemical characteristics and plant food content of chicken manure are presented. The effect of high rates of manure application upon soil test results are shown. The application of 46.4 tons/acre of manure significantly increased the levels of phosphorus, potassium, magnesium, nitrate, and percent of carbon in the soil. At the same time, the pH level was reduced from 7.7 to 7.1. An experiment involving different rates of poultry manure application, one fertilizer application, and no treatment was used to determine the effect of chicken manure on corn grain yield. The use of commercial fertilizer did not increase corn yields. Previous field management made this result expected. The use of several rates of manure has not greatly affected the yields. The use of 46.4 tons/acre tended to decrease corn yields slightly. It is not known at the present time whether this apparent depression is real. The data suggest that a tremendous quantity of chicken manure can be incorporated into the soil without any opportunity for damage to a corn crop. (See also W71-03555) (White-Iowa State)  
W71-03558

#### DRYING ANIMAL WASTE,

Michigan State Univ., East Lansing. Dept. of Agricultural Engineering.

T. C. Surbrook, J. S. Boyd, and H. C. Zindel.

In: Research Report 117, Farm Science, MSU Agricultural Experiment Station, East Lansing, July 1970, p 16-20. 5 tab, 1 fig.

Descriptors: \*Farm wastes, \*Poultry, \*Cattle, \*Hogs, \*Drying, Moisture content, Nutrients, Bulk density, Costs, Screens, Electric power.  
Identifiers: \*Dryer operation, Hammermill, Drying chamber, Fuel consumption.

The report gives details and test results from a machine used for drying animal waste. Production figures for the drier while processing different kinds of animal excreta are given. Details of the drier operation are described. Initial moisture contents ranged from 72 to 82 percent. The machine incorporates inclined shaking surfaces and screens, a hammermill and temperatures from 200 to

1100F. The drier successfully processed dairy, beef, swine and poultry excreta. Costs to produce one ton of the dried product are given. A table gives projected numbers of animals which the machine might serve. Density and nutrient levels of the dried excreta are listed. Odors were less intense than that of fresh excreta. (See also W71-03555) (White-Iowa State)  
W71-03559

#### THE UTILIZATION OF POULTRY WASTE AS A FEEDSTUFF FOR GROWING CHICKS,

Michigan State Univ., East Lansing. Dept. of Poultry Science.

C. J. Flegal, and H. C. Zindel.

In: Research Report 117, Farm Science, MSU Agricultural Experiment Station, July 1970, p 21-28. 5 tab, 21 ref.

Descriptors: \*Farm wastes, \*Poultry, \*Dehydration, Amino acids, Analysis, Chemical properties, Diets, Nutrients, Bacteria, Feeds, Efficiencies, Weight, Mortality.

Identifiers: \*Feed composition, Dehydrated poultry waste, Significance, Feed efficiency.

Two experiments were conducted to determine the nutritional value of dehydrated poultry waste (DPW) for growing chicks from 1 to 28 days of age. The four-week mean body weight of Leghorn-type chicks was not influenced when up to 20 percent of the diet consisted of the DPW. Diets which contained levels of 10 and 20 percent DPW, when fed to broiler-type chicks, resulted in a reduction in four-week mean body weight; 5 percent DPW had no influence on the four-week mean body weight. Food efficiency was inversely related to the level of DPW in the diet; i.e., the higher the level of DPW, the poorer the feed efficiency. However, in the trial in which broiler-type chicks were used, added fat placed in the diet which contained 20 percent DPW improved weight gain and feed efficiency. It is suggested that the DPW used in these trials was a low energy product. (See also W71-03555) (White-Iowa State)  
W71-03560

#### THE RESULT OF FEEDING DRIED POULTRY WASTE TO LAYING HENS ON EGG PRODUCTION AND FEED CONVERSION,

Michigan State Univ., East Lansing. Dept. of Poultry Science.

C. J. Flegal, and H. C. Zindel.

In: Research Report 117, Farm Science, MSU Agricultural Experiment Station, July 1970, p 29-30. 2 tab.

Descriptors: \*Farm wastes, \*Poultry, Eggs, Feeds, Diets, Corn, Lipids, Calcium, Phosphorus.

Identifiers: \*Egg production, \*Feed conversion, Dried poultry waste, White Leghorn layers.

Four replicates of eight birds each were fed one of thirteen possible diets which were presented in tabular form. The 416 White Leghorn type layers were on test for 139 consecutive days. Each hen was confined in an individual cage having a floor area of 8 x 16 inches. The percent egg production on a hen housed basis and kilos of feed per dozen eggs produced are also presented in tabular form. These data are presently being statistically analyzed to determine the differences, if any, between the various treatments. It appears that hens receiving control rations containing 10, 20, and 30 percent dried poultry waste have respectively lower production and higher feed requirements per dozen eggs. (See also W71-03555) (White-Iowa State)  
W71-03561

#### THE EFFECT OF FEEDING DEHYDRATED POULTRY WASTE ON PRODUCTION, FEED EFFICIENCY, BODY WEIGHT, EGG WEIGHT, SHELL THICKNESS AND HAUGH SCORE,

Michigan State Univ., East Lansing. Dept. of Poultry Science.

C. J. Flegal, and H. C. Zindel.

## Waste Treatment Processes—Group 5D

In: Research Report 117, Farm Science, MSU Agricultural Experimental Station, July 1970, p 31-33. 3 tab.

Descriptors: \*Farm wastes, \*Poultry, \*Dehydration, \*Diets, Feeds, Eggs, Lipids, Efficiencies, Performance, Weight, Protein, Nitrogen.  
Identifiers: \*Production, \*Feed efficiency, Body weight, Egg weight, Shell thickness, Haugh score, Significant difference.

In this egg production experiment, one replicate of 18 twenty-six-week-old Leghorn type pullets was placed on each of five different rations. The rations varied from 0% to 40% dehydrated poultry waste (DPW) plus fat. The production trial was conducted for 366 days with the birds in individual cages on a 15-hour-per-day light schedule. Protein-nitrogen supplied in each of the rations was calculated to be equal. The highest percent egg production resulted in those birds which received 10% DPW in the ration. Although production varied from 61.62% to 53.16% production, there was no significant difference in hen housed production. Feed efficiency again was inversely proportional to the amount of DPW in a ration, with the best efficiency having 0% DPW in the ration. However, an addition of animal fat to the ration resulted in a slight improvement in feed efficiency. It is also interesting to note that those birds which received more than 10% DPW in their diet did not increase in body weight comparable to the control ration. The egg weight became smaller as the percent of DPW was increased in the diet. These differences were not significantly different. Although there were slight differences in shell thickness, again there were no significant differences due to the diet in any of these rations. All of the experimental rations had a significantly higher Haugh score than the control diet. The Haugh scores ranged from 67.7 to 76.8. (See also W71-03555) (White-Iowa State)  
W71-03562

#### THE EFFECT OF FEEDING DEHYDRATED POULTRY WASTE TO LAYING HENS ON THE TASTE OF THE RESULTING EGGS,

Michigan State Univ., East Lansing. Dept. of Poultry Science.

C. J. Flegal, H. C. Goan, and H. C. Zindel.

In: Research Report 117, Farm Service, MSU Agricultural Experiment Station, July 1970, p 34-38. 2 tab, 9 ref.

Descriptors: \*Farm wastes, \*Poultry, \*Dehydration, Diets, Eggs, Evaluation, Taste, Control.  
Identifiers: \*Dehydrated poultry waste, Taste test, Consumer Preference Panel.

Poultry feces, from caged layers, were collected and dried. The resulting product was designated as dehydrated poultry waste (DPW). DPW was fed at dietary levels of 10, 20 and 30 percent to Single Comb White Leghorns in individual wire cages. A cage-type laying diet was used as a control. The diets were fed for four months before any eggs were collected for taste panel evaluation. Eggs from each treatment group were hard-cooked and prepared for a Consumer Preference Panel. The eggs were evaluated on the basis of taste difference and then ranked for preferred taste. The dietary levels of DPW fed had no significant (pA.05) effect on the taste of eggs. Panel members were unable to detect any consistent taste difference for the DPW and control eggs. Two thirds of the time, panel members liked the taste of the DPW eggs over the taste of the control eggs. In each ranking test, panel members preferred the control eggs over the DPW eggs. (See also W71-03555) (White-Iowa State)  
W71-03563

#### ACCEPTABILITY AND DIGESTIBILITY OF POULTRY AND DAIRY-WASTES BY SHEEP,

Michigan State Univ., East Lansing.

J. W. Thomas.

In: Research Report 117, Farm Science, MSU Agricultural Experiment Station, July 1970, p 42-44. 2 tab.

Descriptors: \*Farm wastes, \*Poultry, \*Sheep, \*Cattle, Protein, Nitrogen, Animal metabolism, Digestion, Cellulose, Lignins, Fiber, Diets.  
Identifiers: Total digestible nutrients, Dry matter, Digestibility, Soybean meal, Nutritive value.

Dried poultry and dairy wastes as about one third the total mixed ration were readily accepted by sheep. The complete ration was about 60% digestible with a TDN value of about 56. The digestibility of the poultry feces was more than that of the dairy feces. Protein of these wastes was less digestible than that of soybean meal but had a biological value equal to that of soybean meal for growing sheep. (See also W71-03555) (White-Iowa State)  
W71-03564

#### OXYGENATION CAPACITIES OF OXIDATION DITCH ROTORS FOR CONFINEMENT LIVESTOCK BUILDINGS,

Illinois Univ., Urbana. Dept. of Agricultural Engineering.

Don D. Jones, Donald L. Day, and James C. Converse.

Purdue University, Engineering Extension Service, Bulletin No. 135, p 191-208. 12 fig, 5 ref. Proceedings 24th Industrial Waste Conference.

Descriptors: \*Dissolved oxygen, \*Oxygenation, Farm wastes, Equipment, Odor, Mass transfer, Theoretical analysis.

Identifiers: \*Oxidation ditch, Alpha factor.

The oxidation ditch is one of the most successful methods for treating the staggering volume of animal manure that is being produced at the present time. The purpose of this paper is to present the oxygenation capacities of five aeration rotors tested at the University of Illinois. The rotors were tested in actual field installations with clean tap water in the ditch and the livestock removed. The parameter studies were blade immersion, blade design, rotor speed, and gross power requirements. There is little or no difference in oxygenation capacities between the angle iron bladed rotor and the rectangular plate rotor. The increase in oxygenation capacity is almost linear with depth of immersion or rotor speed. (Christenbury-Iowa State)  
W71-03565

#### PRELIMINARY RESULTS OF A NOVEL BIOLOGICAL PROCESS FOR TREATING DAIRY WASTES,

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Ronald L. Antonie, and Fred M. Welch.

Purdue University, Engineering Extension Service, Bulletin No. 135, p 115-126, 1969. Proceedings 24th Industrial Waste Conference.

Descriptors: \*Equipment, \*Aerobic conditions, \*Biological treatment, \*Biomass, Farm wastes, Aeration, Microorganisms, Biodegradation, Chemical oxygen demand.

Identifiers: \*Loading rate, Rotating Biological Contractor, Field test.

Field testing of a device called the 'Rotating Biological Contractor' or 'RBC' is the subject of this paper. The device consists of a series of discs which are mounted on a shaft and rotated while partially submerged in the waste to be treated. A microbial film develops on the surface of the discs. The rotation of the discs carry the microorganisms into the air for aeration so that they can carry on aerobic activity. The field tests have shown that the RBC can effectively treat waste from a dairy plant. Varying weather conditions have no apparent effect on RBC effectiveness. RBC characteristics of a large microbial population, flexible aeration capacity, little maintenance, low power requirements and predictable performance make the RBC an attractive process for biological treatment of dairy wastes. (Christenbury-Iowa State)  
W71-03566

#### MISSION IMPOSSIBLE: DISPOSE ANIMAL WASTES,

Ohio State Univ., Columbus. Dept. of Agricultural Engineering.

E. Paul Taiganides.

Purdue University, Engineering Extension Service, Bulletin No 135, p 542-549, 1969. 1 fig, 4 tab, 10 ref. (Proceedings 24th Industrial Waste Conference).

Descriptors: \*Transportation, \*Disposal, \*Management, Farm wastes, Lagoons, Production, Anaerobic digestion, Aerobic treatment, Biochemical oxygen demand, Gases, Dehydration, Odor.

Identifiers: \*Generation, \*Processing, \*Utilization, Waste management, Anaerobic lagoons, Gas production, Composting.

The development of a 'waste management technology' analogous to the new patterns of animal production and in harmony with our need to keep our natural resources from being polluted is not an impossible mission but rather a challenging mission whose resolution is requiring of engineers and scientists the same ingenuity that has been shown in developing modern methods of production of consumer goods. This paper discusses the changes and trends in the components of animal waste management. The discussion is divided into five areas: waste generation, waste transportation, waste processing, waste utilization and waste disposal. (Christenbury-Iowa State)  
W71-03569

#### AEROBIC DIGESTION OF SWINE WASTE,

Illinois Univ., Urbana. Dept. of Agricultural Engineering.

D. D. Jones, J. C. Converse, and D. L. Day.

Proceedings of CIGR (Commission Internationale du Genie Rural), p 204-211, 1969. 7 fig, 2 ref.

Descriptors: \*Oxygenation, \*Aeration, \*Foaming, Biochemical oxygen demand, Farm wastes, Swine, Lagoon, Dissolved-oxygen, Aerobic treatment, Odor, Gases, Liquid wastes, Waste water treatment.

Identifiers: \*Oxidation ditch, \*Total solids, Loading rate, Defoaming agent, In-the-building treatment.

An oxidation ditch for in-the-building treatment of swine waste was evaluated. Odorless aerobic treatment could be obtained under the self-cleaning slatted floors of a confinement building by connecting the ends of the liquid-manure gutters and adding a rotor aerator. The results indicate that loading rates of 6 cu. ft. or less per hog are not suitable for in-the-building, oxidation-ditch treatment. Loading rates of 8 cu. ft. per hog were most satisfactory. Oil was used as a defoaming agent when required. No foaming was encountered at loading rates higher than 8.5 cu. ft. per hog provided sufficient oxygen was supplied. The mixed-liquor, 5-day BOD of swine waste was reduced from 40,000 to 3,000 to 10,000 milligrams per liter. (Christenbury-Iowa State)  
W71-03570

#### REUSE OF WASH WATER FOR CLEANING CAGED LAYER HOUSES,

North Dakota State Univ., Fargo. Dept. of Agricultural Engineering.

R. L. Witz, G. L. Pratt, and J. L. Sell.

Transactions of the ASAE, Vol 12, No 6, p 807-812, November 1969. 7 fig.

Descriptors: \*Recirculated water, Farm wastes, Poultry, Storage tanks, Equipment, Odor.  
Identifiers: Flushing gutters, Manure.

A liquid manure handling system was designed for a poultry house. Manure is collected in concrete gutters beneath the cages. A flushing process is used to clean the gutters. A wooden scrape is forced down the length of the gutter by pressure exerted by water that had been added behind the

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### Group 5D—Waste Treatment Processes

scrape. The water was collected in an outside pit for reuse. This system has been effective for reducing the total quantity of water required for cleaning the poultry house. (Christenbury-Iowa State) W71-03573

#### AEROBIC DIGESTION OF CATTLE WASTE,

Illinois Univ., Urbana. Dept. of Agricultural Engineering.

D. D. Jones, B. A. Jones, Jr., and D. L. Day.

Transactions of the American Society of Agricultural Engineers, Vol 11, 1968, p 757-761. 18 fig, 2 tab, 4 ref.

Descriptors: \*Farm wastes, \*Cattle, \*Biochemical oxygen demand, Chemical oxygen demand, Aerobic treatment, Sludge, Aeration, Digestion, Regression analysis, Waste treatment.

Identifiers: \*Loading rates, \*Aerobic digestion, Dairy cattle, Beef cattle, Volatile solids, Fixed solids, Digesters.

The effectiveness was studied of the aerobic digestion process in the treatment of dairy and beef-cattle wastes. Waste from livestock being fed a high-concentrate ration was added in varying loading rates to laboratory aerobic digesters. This experiment indicates that, in the future, less emphasis should be placed on COD, VS, and FS and more on the measurement of BOD, which is a better indication of microorganism activity. BOD reductions of 70, 60, and 76 percent and total VS reductions of 20, 15, and 0 percent, respectively were obtained for loading rates of 125, 150, and 200 ml. from dairy cattle. Similar results were obtained using beef cattle waste. Under conditions similar to those prevailing in this study, significant reductions in biodegradable organic concentrations can be obtained. (White-Iowa State) W71-03576

#### HOG WASTE DISPOSAL BY LAGOONING,

Illinois Dept. of Public Health, Springfield, Ill. Div. of Sanitary Engineering.

Charles E. Clark.

Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 91, No SA6, p 27-41, December 1965. 5 tab, 1 fig, 9 ref.

Descriptors: \*Farm wastes, \*Farm lagoons, Odor, Scum, Gases, Bubbles, Biochemical oxygen demand, Chemical oxygen demand, Coliforms, Sampling, Depth, Volume, Septic tanks, Dissolved oxygen, Costs, Nutrients, Chlorophyta, E. coli, Antibiotics, Nitrogen, Potassium, Phosphorus, \*Hogs. Identifiers: \*Lagoon supernatant, Shock loading, Surface area, Farrowing house, Feeding house, Total solids, Volatile solids, Enterococcus, Penicillin, Algal population.

The material presented consists of on-site observations and test results obtained from samples collected from an operational farm lagoon in Illinois. The program centered on this lagoon since others around it had failed. The system itself is described and possible solutions given as to why it does work. Chemical properties of the lagoon supernatant and the raw waste are compared. On the basis of observations made during this program, the most likely problem will be process failure caused by antibiotic effect, temperature change or shock loading. Studies are underway concerning the harvesting and feeding of algae from the lagoon. Operational problems as well as costs are evaluated for the total system. Finally, a practical system is suggested for the disposal of hog wastes. (White-Iowa State) W71-03578

#### POULTRY MANURE DISPOSAL - IS THERE A PROBLEM,

C. T. Riley.

Agriculture, Vol 73, 1966, p 110-112.

Descriptors: \*Poultry, Costs, Nutrients, Farm wastes, Fertilizers, Value, Waste disposal. Identifiers: Muck, Handling, Removal.

The cost is examined associated with removal of poultry manure from the house to the disposal point. It is costing the poultry farmer a shilling per bird per year to remove the muck. The fertilizer value of poultry manure should not be overlooked. Farmers dispose enough manure that would be worth 160 units of nitrogen, 160 units of phosphorus and 70 units of potash if applied to a crop. (Christenbury-Iowa State) W71-03579

#### EFFLUENT DISPOSAL - STILL A MAJOR PROBLEM,

Wright Raine Ltd.

Journal and Proceedings of the Institution of Agricultural Engineers, Vol 21, p 134-139, 1965. 5 fig, 5 tab.

Descriptors: \*Farm wastes, \*Slurries, Sludge, Sprinkler irrigation, Pumping, Storage tanks, Labor, Volume, Rates of application.

Identifiers: \*Field spreading, Vacuum tanks, Mechanical agitation.

Equipment and methods of manure disposal used in handling manure slurries are described. The equipment is broadly divided into two categories including mobile trailer type equipment and pumping equipment. Several examples of each are given. Tables list the waste production and labor required for each system as a function of volume handled. A digester is also described, which reduces the volume of material put in by 20%, and produces a sludge with no smell. It is suggested that the cost of this operation would be prohibitive. A discussion follows centering on problems and solutions to problems which have arisen from the systems discussed. (White-Iowa State) W71-03581

#### THE EFFECTS OF VOLUME AND SURFACE AREA ON THE RATE OF ACCUMULATION OF SOLIDS IN INDOOR MANURE DIGESTION TANKS,

Nebraska Univ., Lincoln.

Ali A. Al-Timimi, W. J. Owings, and John L.

Adams.

Poultry Science, Vol 44, p 112-115, 1965. 3 tab, 4 ref.

Descriptors: \*Farm wastes, \*Poultry, \*Digestion tanks, Volume, Least squares method, Overflow, Lagoons, Waste treatment.

Identifiers: \*Surface area, Dry matter, Hen weight, Feed consumption, Egg weight.

Ten stainless steel tanks were utilized to form four volume and two surface area allowances. Leghorn type pullets were placed in eight inch cages over the tanks and their manure was allowed to accumulate in liquid for 20 weeks. At the end of each 2 week period, dry matter determinations were made and hen weight, feed weight and egg production were recorded. The dry matter percentages were put on a 3.5 cu. ft/bird basis and the changes in per cent dry matter from one period to another were calculated. Cubage and surface area per bird seemed to have no significant effects on the rate of digestion of the solids in the tanks. Periods and the interaction between treatments and periods were highly significant. Although the manure output is influenced by factors such as hen weight, feed consumption and egg weight, none of these factors showed any significant effect, because of the uniform distribution of the hens assigned to the treatments. Liquid overflow was inversely related to the surface area per bird. At least 3.5 cu. ft of water per bird is needed to provide for biennial cleaning. (White-Iowa State) W71-03582

#### A NOTE ON THE UTILISATION BY CHICKENS OF ENERGY FROM FAECES,

Queensland Univ., Brisbane (Australia). Dept. of Animal Husbandry.

W. J. Pryor, and J. K. Connor.

Poultry Science, Vol 43, p 833-834, 1964. 2 tab, 2 ref.

Descriptors: \*Farm wastes, \*Poultry, Energy, Wheat, Sorghum, Nitrogen.

Identifiers: \*Metabolizable energy, Bomb calorimeter, Ration.

Four groups of male chickens aged 22 days which had been on a trial to determine the metabolizable energy of grain sorghum, were allotted at random two to each treatment. Two groups were fed crushed grain sorghum. The remaining two groups were fed a ration consisting of 80% crushed grain sorghum mixed with 20% feces resulting from a previous wheat trial. All four rations contained a standard broiler mineral and vitamin supplement. The results showed that the feces had a metabolizable energy value of approximately 30% of the feed from which it originated. (White-Iowa State) W71-03583

#### THE MANAGEMENT OF LIVESTOCK MANURE,

California Univ., Davis. Dept. of Agricultural Engineering.

S. A. Hart.

Transactions of the ASAE, Vol 3, p 78-80, 1960. 4 fig, 1 tab, 13 ref.

Descriptors: \*Farm wastes, \*Disposal, \*Management, Storage, California, Dehydration, Livestock, Fertilizers, Value.

Identifiers: \*Composting, \*Sanitation, Processing, House fly, Musca domestica, Carbon to nitrogen ratio, Production.

Manure management will seldom be a profit-making part of the farming enterprise. In most cases the cost of proper handling will exceed the value of the manure as a fertilizer or soil amendment. Even so, manure handling is as necessary a chore as is feeding or animal care. Through proper manure management the net cost of handling the manure can be minimized and the sanitation requirements of the farming operation fulfilled. The procedures of systems engineering are applicable to the management of livestock manure, and can be stated as the specific operations of: (a) gathering and cleaning up the manure, (b) storing or processing it, and (c) utilizing or disposal of it. (Christenbury-Iowa State) W71-03584

#### SWINE WASTE MANAGEMENT-ANAEROBIC LAGOONS,

Illinois Univ., Urbana. Dept. of Agricultural Engineering.

Arthur J. Muehling.

Cooperative Extension Service, University of Illinois at Urbana-Champaign, August 1969. 2 p. AENG-877.

Descriptors: \*Hogs, \*Farm wastes, \*Anaerobic conditions, \*Lagoons, Size, Sites, Construction, Shape, Depth, Odors, Sludge, Water pollution, Temperature, Intakes, Outlets, Grading, Management, Mixing, Organic matter, Stabilization.

Identifiers: \*Loading rates, \*Location, Solids, Wind action, Gas bubbling, Volatile solids.

Anaerobic lagoons were first adapted for the storage and treatment of hog wastes because of their low initial cost, ease of operation, and lack of serious alternatives. They have not always been successful, for sometimes they release objectional odors, they can pollute surface and underground water, they sometimes do not decompose the manure adequately, and in time they are apt to fill up with sludge. This fact sheet gives advice as to loading rates, size and location of anaerobic lagoons. Attention is given to the construction shape, depth, inlets and outlets, fencing, and grading of banks. Management practices include an adequate supply of water, correct start-up, continuous loading rates, restriction of solids, and adequate mixing. (White-Iowa State) W71-03585

## Waste Treatment Processes—Group 5D

**SWINE WASTE MANAGEMENT - CASES FROM STORED SWINE WASTES,**  
Illinois Univ., Urbana. Dept. of Agricultural Engineering.  
Arthur J. Muehling.  
Cooperative Extension Service, University of Illinois at Urbana-Champaign, August 1969. 2 p. AEng-879.

Descriptors: \*Farm wastes, \*Hogs, \*Gases, Odors, Carbon dioxide, Ammonia, Hydrogen sulfide, Methane, Lagoons.

Identifiers: \*Threshold limit values (TLV), Air quality, Irritation, Lethal situations, Storage pit, Concentrations, Asphyxiation, Symptoms.

This fact sheet concerns itself about the quality of the air inside confinement swine buildings with slotted floors since the wastes may be held in the building long enough to produce gases and odors. Noxious gases and odors formed from stored wastes can be irritating to both the hogs and operator and have been the cause of numerous complaints and even lawsuits by neighbors. The most important gases generated from stored manure, and those discussed by the fact sheet are carbon dioxide, ammonia, hydrogen sulfide, and methane. The potentially lethal situations of ventilation breakdown, agitation of storage pit, and entering a storage pit are discussed and warnings given. (White-Iowa State)

W71-03589

**SWINE WASTE MANAGEMENT - OXIDATION DITCH FOR TREATING HOG WASTES,**  
Illinois Univ., Urbana. Dept. of Agricultural Engineering.

Arthur J. Muehling.  
Cooperative Extension Service, University of Illinois at Urbana-Champaign, August 1969. 2 p. AEng-878.

Descriptors: \*Costs, \*Farm wastes, \*Hogs, \*Design, \*Rotors, Effluent, Volume, Storage, Oxygen, Biochemical oxygen demand, Aerobic bacteria, Organic matter, Calibrations, Foaming, Microorganisms, Odors, Dissolved oxygen, Color, Anaerobic bacteria, Sludge.

Identifiers: \*Oxidation ditch, Rotor capacity, Rotor immersion, Rate of flow, Configuration, Detention time.

There has been considerable interest in aerobically treating hog wastes in an oxidation ditch because of the need for a low-odor method of manure storage and treatment. This fact sheet gives guidelines as to design shape, capacity and loading, rotor capacity and immersion, liquid depth and rate of flow. Operational procedures are given as well as a discussion of problems that may arise. Solutions to the problem of foaming include vegetable or petroleum oil, commercial products or a water spray. Sludge buildup and final disposal are given some attention. Rotor costs are about \$250 per foot and operation costs are estimated to be between 1/2 and 1 cent per day per hog. (White-Iowa State)

W71-03587

**CONFINEMENT SWINE HOUSING - SLOTTED FLOORS,**  
Illinois Univ., Urbana. Dept. of Agricultural Engineering.

Arthur J. Muehling.  
Cooperative Extension Service, University of Illinois at Urbana-Champaign, August 1969. 2 p. AEng-875.

Descriptors: \*Construction materials, \*Reinforced concrete, \*Metals, Farm wastes, Dimensions, Corrosion, Failure, Durability, Depth, Height, Length, Reinforcement, Hog.

Identifiers: \*Slotted floors, \*Wood, \*Spacing, Expanded metal, Farrowing, Feed wastage.

This fact sheet lists wood, concrete and metal as being effective for slotted floors. Advantages and disadvantages of each type are given, as well as dimensions that should be used. Expanded metal

and steel straps are both discussed as to their effectiveness for slotted floors. The amount and kind of reinforcing to use in concrete slats is given. Recommended spacing and advice for farrowing on slotted floors is also given. Pens with totally slotted floors remain consistently cleaner than those partially slotted. In general, the larger the pig the wider the slot that can be used without sacrificing cleaning efficiency. (White-Iowa State)

W71-03589

**CONFINEMENT SWINE HOUSING - SPACE REQUIREMENTS,**  
Illinois Univ., Urbana. Dept. of Agricultural Engineering.

Arthur J. Muehling.  
Cooperative Extension Service, University of Illinois at Urbana-Champaign, August 1969. 2 p. AEng-874.

Descriptors: \*Size, \*Seasonal, \*Temperature, \*Ventilation, Farm wastes, Hogs, Confinement pens, Management, Performance, Economics.

Identifiers: \*Space requirements, Method of feeding, Number of pigs per pen, Heat stress.

As confinement housing has changed to include total enclosure of feeding and sleeping area under roof, the minimum space requirements recommended for pigs in confinement have been reduced. These recommendations indicate the minimum amount of floor space per pig necessary to prevent a significant reduction in pig performance and to maintain a reasonable degree of cleanliness in the pen. The fact sheet lists space requirements for different weight ranges of hogs. These recommendations are based on research that has considered the more important factors affecting space needs. The factors discussed in the fact sheet include size of animal, season (as related to temperature), ventilation, method of feeding, level of management, and number of pigs per pen. (White-Iowa State)

W71-03590

**A GROWING MARKET FOR WATER AND WASTEWATER TREATMENT EQUIPMENT,**  
Business and Defense Services Administration, Washington, D.C. Water Resources and Engineering Services Div.

K. I. Kollar, and William G. Youngwirth.  
Water and Sewage Works, Vol 117, No 9, September 1970, p 319-325. 7 tab, 2 charts.

Descriptors: \*Cost comparisons, \*Cost analysis, \*Surveys, \*Costs, Construction costs, Evaluation, Economics, Equipment, Prices, Water treatment, Waste water treatment.

Identifiers: \*Cost data, \*Cost surveys, Market research.

This paper presents data obtained from questionnaire response of water and waste water treatment equipment manufacturers. The questions related to the manufacturing plant capacity, and the values of shipments of various kinds of water and waste water treatment equipment. The results of surveys conducted in 1965 and 1968 are reported. Tabulated data include: a summary of total expenditures and values of shipments of major equipment items; the sizes of manufacturing establishments based on the value of shipments; the value of all shipments of specific equipment items broken down into water treatment and waste treatment categories; values of total shipments and production capacities for plants manufacturing water and waste water treatment equipment; a comparison of the gross national product, total municipal water and waste water expenditures, and federal grants. In addition, charts showing municipal expenditures for water supply and waste water disposal from 1960 to 1980 (est.) are given. The collected data indicate that water and waste water treatment equipment account for 4.2% of total municipal expenditures, and 15.9% of total municipal treatment facilities expenditures. Approximately 11.2% of industrial construction costs are for water and waste water treatment equipment. (Hewett-Rutgers)

W71-03774

W71-03597

**INDIVIDUAL WASTE DISPOSAL SYSTEMS,**  
Connecticut Univ., Storrs.

W. C. Wheeler, J. J. Kolega, R. P. Prince, and G. W. Hawkins.

Research Project Technical Completion Report, June 30, 1970. 8 p, 3 ref. OWRR Project A-001-CONN-4.

Descriptors: \*Septic tanks, Waste water treatment, \*Waste water disposal, \*Aeration, \*Temperature, Effluents, Spectrophotometry, Biological treatment, Pumping, Chemical oxygen demand, Hydrogen ion concentration.

Identifiers: Aspirators, Air diffuser, Synthetic effluent, Differential pumping.

Solutions containing trypticase soy as the primary degradable contaminant were found to give reproducible results when used as the influent for studies using model septic tanks. When spectrophotometer readings for light emissivity of refluxed samples were applied to curves established for the media being used, the readings obtained were dependable COD indications. The efficiency of biological treatment processes in model septic tanks of the same volume was best for the tanks having the greatest surface areas. A sudden expansion type of aspirator was developed for adding air to liquid. It was more efficient than several other devices tested. The aspirator was used with a two-compartment aeration tank and a differential pumping scheme to produce effluent of excellent quality.

W71-03774

**THE ISOLATION OF PROTOZOA AND ALGAE FROM THEIR BACTERIAL CONTAMINANTS,**  
Massachusetts Univ., Waltham. Dept. of Environmental Sciences.

For primary bibliographic entry see Field 05F.

W71-03775

**EVALUATION OF PYRRONES AS MEMBRANES,**

Franklin Inst. Research Labs., Philadelphia, Pa.

H. Scott, and F. L. Serafin.

NASA CONTRACTOR REPORT NASA CR-1648, September 1970. 35 p, 8 tab, 15 fig, 10 ref. Contract NAS 1-8609.

Descriptors: \*Membranes, Desalination, Urine, Water purification, \*Reverse osmosis, \*Osmosis, Waste water treatment.

Identifiers: Polymidazopyrrolones, \*Pyrromes.

The facile absorption of water by polyimidazopyrrolones (Pyrromes) suggested a feasibility study to use films of the polymers as membranes for the purification of water by reverse osmosis. This report describes direct osmosis measurements of water, salt, and urea fluxes through Pyrrome membranes. The data indicate comparable flux values and superior water-to-salt permeabilities of the Pyrromes relative to symmetric cellulose acetate membranes. Coupled with better mechanical strength and chemical resistance, these results suggest that the successful fabrication of asymmetric Pyrrome membranes could lead to substantial improvements over asymmetric cellulose acetate, from which the best reverse osmosis membranes are currently prepared.

W71-03780

**DESIGN OF PLUG-FLOW POST-AERATION BASINS,**  
Rex Chainbelt, Inc., Milwaukee, Wis. Process Equipment Div.

Richard A. Kormanik.

Journal Water Pollution Control Federation, Vol 42, No 11, November 1970, p 1922-1931. 5 fig, 2 ref.

Descriptors: \*Aeration, Design, \*Oxygenation, Sewage treatment, Waste water treatment, Dis-

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

solved oxygen, Effluents, Sewage effluents, Storage.  
Identifiers: Post-Aeration Basins, Dissolved Gases, \*Air-Diffusers, Detention time.

Regulatory agencies have begun to set requirements stipulating minimum allowable dissolved oxygen levels. Since most treatment process produce effluent meeting the required dissolved oxygen levels, post-aeration is required. This paper presents the development of design procedure for describing mathematically a plug flow post-aeration system utilizing diffused aeration. The developed design equations, as is the case for the completely mixed system, indicate that when the waste effluent flow is considered to have an oxygen utilization rate equal to zero, the post-aeration basin detention time does not become a design parameter of the system, and with an oxygen utilization rate taken under consideration, the number of air diffuser units required becomes proportional to the detention time. (Selby-Texas)  
W71-03808

#### THE KINETICS OF ANAEROBIC LONG CHAIN FATTY ACID DEGRADATION,

Missouri Univ., Columbia. Dept. of Civil Engineering.

John T. Novak, and Dale A. Carlson.

Journal of the Water Pollution Control Federation, Vol 42, No 11, Nov 1970, p 1932-1943. 12 fig, 1 tab, 26 ref.

Descriptors: \*Anaerobic digestion, Acids, Degradation, Waste water treatment, Metabolism, Oxidation, Kinetics, Sludge, Effluents, \*Sludge digestion, Digestion, Storage, Liquid wastes.  
Identifiers: \*Fatty acids, Detention time.

Greases normally account for about 30% of the volatile matter in raw waste water sludge. The purpose of this study was to determine the rate at which fine selected long chain fatty acids could be degraded in an anaerobic system under optimum conditions. These fine fatty acids, which comprise about 90% of the fatty acids commonly found in waste water sludge, were each fed continuously to completely mixed laboratory anaerobic digestion units along with the necessary inorganic nutrients. Data were analyzed using a kinetic model based on the Monod equation which relates the biological solids retention time (SRT) to the effluent substrate concentrations. The degradation rates of the fine fatty acids fell into two groups: (1) the unsaturated acids were degraded most rapidly, undergoing greater than 90% removal at a detention time of 10 days and (2) rates of degradation of the saturated 14-, 16- and 18-carbon fatty acids were much slower and a decreasing rate was observed to occur with increasing chain length. (Selby-Texas)  
W71-03809

#### INDUSTRIAL WASTE TREATMENT-FACT AND FICTION,

Atlantic Richfield Co., Philadelphia, Pa. Air and Water Conservation.

William B. Halladay.

Journal Water Pollution Control Federation, Vol 42, No 11, November 1970, p 2004-2008.

Descriptors: \*Waste water treatment, \*Industrial wastes, Legislation, Water Quality Act, Water quality.

Because there are many misconceptions about the efforts of industry to control water pollution, this paper attempts to distinguish some of the things that may be considered real or fictitious in the progress and development of industrial waste treatment today. Industry participated in hearings held to establish water quality standards under the Water Quality Act of 1965, and industry became aware of the necessity of pollution control programs. These programs are advancing but are hampered by lack of financing and the need for new technological breakthroughs. Some of the fictions the author refutes are that industry creates most

pollution, that the nation is running out of water, that industry has all necessary techniques to clean up water, and that different types of pollution can be attacked piecemeal. Strong and weak points of the legislation is discussed. (Selby-Texas)  
W71-03810

#### DEVELOPING A REGIONAL WASTE WATER SYSTEM,

Brazos River Authority, Waco, Tex.

Ross L. Jacobs, and Carson H. Hoge.

Journal Water Pollution Control Federation, Vol 42, No 11, November 1970, p 1951-1961. 1 tab.

Descriptors: Waste water disposal, Legislation, Texas, Industrial wastes, \*Sewage districts, \*Regions, Municipal wastes.

Identifiers: Revenue, Urban areas, Systems management.

Problems connected with providing for the proper collection and treatment of liquid wastes in metropolitan areas may often best be dealt with by providing a regional sewage system to serve several or all of its separate municipalities. This paper presents a history of regional systems in Texas. Problems that prompted the development of systems and the steps taken provide an overview of typical factors involved in such an effort. Engineering, legal, financial problems, industrial wastes, waste water concentration and components, bonding, and communications are the considerations discussed as they relate to Texas metropolitan areas. The report concludes that the Texas Water Quality Board and the FWQA have long recognized the advantages of a regional sewage system in urban metropolitan areas as a means of reducing pollution of the rivers and streams of the state, and that they have given a great deal of support to such systems that have been developed. (Selby-Texas)  
W71-03811

#### FILTRABILITY INDEX AND MICROSCREENER DESIGN,

Research Triangle Inst., Durham, N.C.

Forest O. Mixon.

Journal Water Pollution Control Federation, Vol 42, No 11, Nov. 1970, p 1944-1950. 3 fig, 7 ref.

Descriptors: Design, Waste water treatment, Filtration, Screens.

Identifiers: \*Filtrability index, \*Microscreeners, Boucher theory, Microtraining.

The concept of filtrability index seems to be erroneously applied in the literature to the design of continuous rotary drum microscreens. A revised version of microscreener theory is proposed in which the concept of the filtrability index is introduced slightly differently than in the past. New equations are presented for microscreener design, that predict operating capacities about 30% in excess of those predicted by the Boucher Theory. (Selby-Texas)  
W71-03812

#### RAW SLUDGE PUMPING PROBLEMS AND INTERDISCIPLINARY SOLUTIONS,

Boston Metropolitan District Commission, Mass. Deer Island Sewage Treatment Plant.

Andrew P. Fisichelli.

Journal Water Pollution Control Federation, Vol 42, No 11, November 1970, p 1916-1921.

Descriptors: Sludge treatment, Maintenance, Sludge, Waste water treatment, Pumping, Massachusetts, Screens.

Identifiers: \*Raw sludge, \*Sludge pumping, Check valves, Grease buildup, Boston (Mass.).

The operating problems of line plugging and check valve obstruction in raw sludge handling and transporting are reported. The research of this study pertains to the Deer Island Plant, Metropolitan District Commission, Boston, Massachusetts. The problems were minimized by improving the effec-

tiveness of the screening operation and eliminating or minimizing grease and oil buildup. Screening problems were reduced by eliminating the use of grinders and not returning screenings to the flow and the use of differential head pressure (upstream-downstream of the screen) as the primary control for the cleaning mechanism. A creosote-base fuel oil solvent used once per week controlled grease accumulation. These problems are common to all sizes of waste treatment facilities in varying degrees. (Selby-Texas)  
W71-03813

#### WATER AND WASTE WATER SYSTEMS TO COMBAT CHOLERA IN EAST PAKISTAN,

Rader and Associates, Miami, Fla.

DeSoto B. McCabe.

Journal Water Pollution Control Federation, Vol 42, No 11, November 1970, p 1968-1981. 1 tab.

Descriptors: Sanitary engineering, Waste water treatment, Water supply, Design, \*Water treatment, \*Public health, \*Environmental sanitation.  
Identifiers: \*Asiatic cholera, Systems engineering, East Pakistan.

Because East Pakistan is the 'incubator' of the world's cholera, it was chosen as the location for an intensive cholera research laboratory. This paper reports on the factors that must be taken into consideration in attempting to improve the sanitary conditions of the Bengalese people of East Pakistan, whose customs are related to the high incidence of Asiatic cholera. Population density, family living habits, transportation facilities, and education are factors. The U. S. Government financed a study of the feasibility of constructing water and waste water systems in Dacca in 1950. Project design philosophy and project scope are discussed. The project was revised, taking into consideration information obtained in the initial study. Existing facilities, operating procedures and water supplies were considered; the system design was planned for stage development, the first stage covering 10 years. (Selby-Texas)  
W71-03814

#### COSTS AND MANPOWER FOR MUNICIPAL WASTE WATER TREATMENT PLANT OPERATION AND MAINTENANCE, 1965-1968,

Federal Water Quality Administration, Washington, D.C.

Robert L. Michel.

Journal Water Pollution Control Federation, Vol 42, No 11, November 1970, p 1883-1910. 20 fig, 31 tab, 9 ref.

Descriptors: \*Waste water treatment, Economics, \*Municipal wastes, Variable costs, Unit costs, Electric power, Operating costs, Maintenance, Sewage treatment, \*Personnel, \*Costs.  
Identifiers: Municipal waste water treatment.

Between 1965 and 1968, data was taken from 1,600 plants during a study of labor, electrical, and chemical costs of waste water treatment operation and maintenance. Unit costs (dollars or man-hours expended per unit load) declined exponentially with increased plant size, thereby showing economics of scale. Labor and supervision accounted for 50 to 60% of operation and maintenance expenditures, with electric power ranking next in importance, particularly in activated sludge plants. Chlorination operating expenses were about 3% of total operating costs. Oxidation lagoons were shown to be an inexpensive form of treatment to operate. Use or non-use of sludge processing equipment is the most critical factor in operation and maintenance costs. Vacuum filters are especially expensive to operate. (Selby-Texas)  
W71-03815

#### A DISCUSSION OF 'CONCEPTIONS AND MISCONCEPTIONS IN BIOLOGICAL OXIDATION,'

Clemson Univ., S.C.

John F. Andrews.

## Waste Treatment Processes—Group 5D

In: *Advances in Water Quality Improvement*, University of Texas Press, Austin, Texas and London, England, 1968, p 176-177. 1 tab, 3 ref.

Descriptors: \*Biological treatment, \*Oxidation, Trickling filters, Activated sludge, Methane, Bacteria, Waste water treatment.

Identifiers: \*Biological oxidation.

The author refers to the article 'Conceptions and Misconceptions in Biological Oxidation' by A. W. Busch. (See W70-04773). The author says Busch has calculated using a 1 micron film thickness and spheres 3 inches in diameter that a trickling filter would contain less than 1 mg of solids/l of filter volume. When this is compared to the 2000-4000 mg/l of solids commonly found in the conventional activated sludge aeration tank it would appear that the trickling filter process is more inefficient (per unit volume) than the activated sludge process by several orders of magnitude. Even if the film thickness were 100 microns, the activated sludge aeration tank would still contain a much larger quantity of solids per unit volume than the trickling filter. The actual picture is not as black as that painted by Prof. Busch. If one compares the 2 processes, as currently used, it will be found that there is not a great deal of difference in the volumetric loading rates of the 2 processes. This is tabulated. Advances in solid-liquid separation devices and gas transfer devices will undoubtedly increase the allowable volumetric loading rates for the activated sludge process. Advances such as the controlled filtration process of Ingram's should also increase the allowable volumetric loading rates for the trickling filter process. Busch has also hypothesized that methane production may be a result of the effect of environment on the more common bacteria; and, therefore, the methane bacteria may not exist as separate species. He offers no evidence. P. H. Smith has recently conducted experiments, using pure cultures, which appear to disprove Prof. Busch's hypothesis. (See also W70-04761) (Selby-Texas)

W71-03816

#### DISCUSSION OF FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS, Manchester Univ. (England).

J. B. White.

In: *Advances in Water Quality Improvement*, University of Texas Press, Austin, Texas and London, England, 1968, p 203.

Descriptors: \*Activated sludge, \*Design, Aeration, Flocculation, Waste water treatment, Sewage treatment.

Identifiers: \*Simplex, Circulator, Detention period, Immersion.

Since World War II, plant scale work has been carried out at the Manchester, England, treatment plant to guide the design of new works recently completed. The developments have been carried out in close collaboration with machinery manufacturers, resulting in a significant improvement in the design of 'Simplex' surface aeration units. The designed efficiency of the Mark III E type, installed at the new plant, is 4 pounds oxygen for brake horse-power-hour, and it achieves intensive aeration without danger to the sludge floc. The aerator plant consists of 8.8 pockets, each 35 feet square and 10 feet deep. Each pocket has a Mark III E aerator rotating at 45 rpm and absorbing 20 bHP under maximum immersion conditions. The detention period is 2.82 hours. The sewage treated is very strong and contains a large fraction of industrial wastes. Detention periods three or four times longer would previously have been required. The horsepower per million Imperial gallons treated is 33 for aeration alone. Recirculation of activated sludge requires further 7 HP per million gallons. (See also W70-04775 and W70-04761) (Selby-Texas)

W71-03817

#### A DISCUSSION OF 'ANAEROBIC TREATMENT OF SOLUBLE WASTES,' Clemson Univ., S.C. John F. Andrews.

In: *Advances in Water Quality Improvement*, University of Texas Press, Austin, Texas and London, England, 1968, p 353-354. 5 ref.

Descriptors: \*Anaerobic conditions, \*Trickling filters, Biological treatment, Oxidation, Solubility, Wastes, Waste water treatment.

Identifiers: \*Anaerobic treatment, Filter media, Hydraulic upflow.

The author refers to 'Anaerobic Treatment of Soluble Wastes' by P. L. McCarty. (See W70-04783). McCarty has stated that his proposed process (Anaerobic trickling filter with hydraulic upflow) is limited to soluble wastes and has performed his experiments using the soluble substrates methanol, formic acid, acetic acid, and propionic acid. He has shown in these experiments that the process gives a high percentage of COD removal with a low solids concentration in the effluent. However, by using soluble substrates which are directly metabolized by the methane bacteria he has neglected solids produced in the conversion of such soluble wastes as sugars to volatile acids. Speece and McCarty have shown that this can be significant in that as much as 0.46 grams of solids can be produced per gram of glucose COD utilized. They also indicate that the major portion (0.406 gm) are produced in the conversion of glucose to volatile acids. The solids produced are destroyed at a relatively low rate and may result in the clogging of the filter media and/or pass over in the effluent from the reactor. The filter media used by McCarty may be unnecessary. A vertical multi-stage reactor, such as that proposed by Gates et al., would make more efficient use of the reactor volume, reduce the danger of clogging and permit the digestion of both soluble and insoluble wastes. This upflow reactor consists of a mixed lower chamber in which anaerobic decomposition occurs, a solids separator just above the lower chamber which returns solids to the lower chamber, intermediate baffles to prevent oxygen from the aerobic compartment from reaching the anaerobic chamber and separator, and an upper chamber for odor control. (See also W70-04761) (Selby-Texas)

W71-03818

#### PROBLEMS OF POLLUTION CONTROL, Oklahoma State Univ., Stillwater. Engineering and Industrial Extension.

James H. Sudreth.

Proceedings available from Oklahoma State University, Engineering and Industrial Extension, Stillwater, Okla, Price: \$5.00. Proceedings, 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 1-6.

Descriptors: \*Water pollution, \*Water pollution control, \*Pollution abatement, Waste water treatment, Operations and maintenance, Sewage treatment, Water quality control.

The primary purpose of ancient sewers was ground and surface drainage. The use of water for collection and transport of human wastes was not generally adopted until the nineteenth century. Eventually, sewage production and discharge to streams surpassed the ability of the stream to assimilate the waste and pollution resulted. Therefore, it became necessary for man to treat his waste water before discharging it to the receiving stream. The following steps are recommended for solving pollution control problems at the treatment plant level. Recognize the problem, gather the data, list possible solutions, test possible solutions, select final solution, implement solution, follow up action. The individual waste water treatment plant operator must make decisions daily. It is important that he have all the facts available, know the importance of time in the problem, understand the implication of action vs. inaction, and be able to implement his decision. Adequate knowledge of

plant unit operations and preventive maintenance help the operator avoid embarrassing problems. Three example problems and their solutions are discussed in an effort to illustrate problems that occur in waste water treatment plants. (See also W71-03820 thru W71-03829) (Makela-Texas) W71-03819

#### OPERATION AND MAINTENANCE OF A PRIMARY CLARIFIER, Shawnee Water and Sewer Dept., Okla. Del Chanceller.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 7-13.

Descriptors: \*Sewage treatment, \*Operation and maintenance, \*Settling basins, \*Sedimentation, Settling velocity, Septic tank, Waste water treatment.

Identifiers: \*Primary treatment, Imhoff tank, \*Clarifiers.

This article gives a basic review of the purposes of a primary settling tank, the types of tanks commonly found, and the operation and maintenance of settling tanks. The purpose of a primary settling tank is to remove settleable solids by reducing the velocity of waste water flow. Four types of settling tanks in use are the septic tank, the Imhoff tank, the rectangular sedimentation basin, and the circular sedimentation basin. The Imhoff tank combines solids settling and digestion in one unit. Control of foaming in the Imhoff tank and routine operations are discussed. Expected removal rates are 40-60% for suspended solids and 25-35% for BOD. Inlet design, use of baffles, outlet weir design, surface settling rate, and detention time are discussed for rectangular and circular tanks. Circular tanks have greater structural strength and are more economic to build than rectangular tanks. Suspended solids removal rates of 90-95% and BOD reduction of 35-45% can be expected. Routine operations are discussed with emphasis on sludge removal and preventive maintenance. (Makela-Texas) W71-03820

#### BUTTERFLY VALVES, Dresser Research, Tulsa, Okla.

William C. Gilmore.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater, (1969), p 14-26.

Descriptors: \*Butterfly valves, \*Valves, Flow control, Operation and maintenance, Water distribution, Water treatment, Waste water treatment.

Identifiers: Butterfly valves.

Some advantages of the butterfly valve are simplicity of construction, low initial cost, bottle-tight shutoff, ease of operation, and a minimum of maintenance. Initial valve costs are low due to lack of need for expensive modifications to pipe layout. Butterfly valves weigh one third as much and occupy one half as much space as conventional gate valves. Installation is easier. The valve can be operated by one man. 100% bottle-tight shutoff at full rated pressure is obtainable. Corrosion is reduced by use of cast iron, 304 steel, rubber and Teflon for all wetted parts. Head loss is equivalent to a pipe elbow, but greater than losses in other type valves. (See also W71-03819) (Makela-Texas) W71-03821

#### WATER FILTRATION, Oklahoma State Univ., Stillwater.

A. Y. Hyndshaw.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 27-36.

Descriptors: \*Filters, \*Filtration, \*Water treatment, Water purification, Activated carbon, Sands, Uniformity coefficient, Waste water treatment.

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5D—Waste Treatment Processes

Identifiers: Filter media, Anthracite, Mixed media filtration.

A review of water treatment by filtration is presented. The early history of water filtration, and the discovery that pathogenic organisms were removed by filtration are discussed. Filters may be classified by force of movement, rate of filtration, filter material, or application. Rapid sand filters are the most popular and most common type filter in use. They are generally operated at 2-4 gallons per square foot per minute and are preceded by coagulation and sedimentation. General design criteria include 8-10 ft. overall basin depth, 12-15 inches underdrain, 9-18 inches support media, 24-30 inches filter media, 4-5 ft. water depth, and one foot of freeboard. Filter media effective size and uniformity coefficients are given for sand, anthracite, activated carbon, and mixed media. Rapid sand filters are usually gravity operated at 2-4 gpm/ft sq. Backwashing is necessary when head losses reach 8-9 ft. Bed expansion of 20-60%, (40% avg.) is desired. Backwash for 5-10 minutes is required every 12-40 hours for single media, and 25-85 hours for mixed media. Media effective size and depth are determined by head loss and floc penetration characteristics of the media. Mixed media filtration is the most important development since the introduction of rapid sand filtration. Mixed media filtration allows removal in depth, thereby achieving greater filtration efficiency and filter runs 2 1/2 times longer than single media. For most efficient operation, mixed media must expand at the same rate during backwashing. Bacteria and grease coatings on activated carbon decreased efficiency and may require carbon regeneration. (See also W71-03819) (Makela-Texas)

W71-03822

#### NEW DEVELOPMENTS IN AUTOMATIC CATHODIC PROTECTION FOR WATER STORAGE TANKS, Oklahoma State Univ., Stillwater.

Ed Morris.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 37-44.

Descriptors: \*Cathodic protection, \*Automatic control, Corrosion, \*Corrosion control, Electrodes, Potentiometers, Waste water treatment, \*Storage tanks, Storage.

Identifiers: Potentiostat polarization control.

The development of potentiostat polarization control is the latest development in automatic cathodic protection for water storage tanks. The rate of corrosion activity within a structure varies with many factors including water resistivity changes, water corrosivity changes, accumulated ampere hour effect, loss of coating effectiveness, anode consumption, and water level fluctuation. Automatic corrosion control devices require consideration of all these variables. Early corrosion control devices depended on a constant corrosion activity for maximum effectiveness and consisted of a rectifier and anode system. The automatic potential control developed in the early 1960's consisted of a reference electrode continuously monitoring the structure potential and regulation circuit which controlled D.C. output from the anode system. A limitation of this method of corrosion control was the fact that only one reference electrode was used and it measured the potential on only a small area of the structure. Also a copper/copper sulfate reference electrode could not be used because of inability to maintain a saturated copper sulfate solution when in water service. To overcome these limitations the potentiostatic polarization control was developed. It features the use of a copper/copper sulfate electrode, which maintains the desired potential of -0.85 volts. The new system offers three separate control circuits for the application, regulation, and measurement of cathodic protection. The most dramatic improvement is the bridge circuit potentiostat polarization control similar to a wheatstone bridge electrical circuit. This circuit allows the measurement of structure potentials free of IR drops in the water and coating.

W71-03823

#### SLUDGE HANDLING AND DISPOSAL, Tennessee Dept. of Health.

H. B. Rosson.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 45-52. 2 ref.

Descriptors: \*Sludge, \*Sludge treatment, \*Sludge disposal, Sludge digestion, Fertilizers, Waste water treatment, Waste disposal.

Identifiers: Sludge handling, Composting.

Seawage sludge is the accumulated settled solids removed from sewage by sedimentation. Descriptive of source, it may be termed primary, secondary, excess activated, or chemical. Descriptive of treatment received, it may be termed raw, digested, elutriated, dewatered, or dried. The solids content of sludges vary from 0.5% to 15% depending on the treatment received. Economic values in sludge include its potential use as animal feed, fertilizer, high calorific fuel (7,700 BTU/pound raw solids), and production of useful combustible gases when anaerobically digested 770BTU/cubic foot of gas). The primary purposes of sludge treatment are reduction of sludge volume and destruction of its putrescibility. Unit operations useful are thickening, chemical conditioning, elutriation, biological floatation, vacuum filtration, air drying, heat drying, digestion, incineration, or a combination of the above. Final disposal methods used include landfill, incineration and landfill, ocean disposal, lagooning, use as fertilizer and composting. A Johnson City, Tennessee plant, now composts the city's refuse and sludge together producing 25 tons/day of mixed compost. Sludge is used at the rate of 12% by weight for best results. (See also W71-03819) (Makela-Texas)

W71-03824

#### CHLORINATION OF WASTE WATER, Tennessee Dept. of Health.

H. B. Rosson.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 53-60. 6 ref.

Descriptors: \*Chlorination, \*Waste water treatment, \*Sewage treatment, Disinfection, Odor, Corrosion control, Effluents, Public health, Environmental sanitation, Diseases.

Identifiers: \*Chlorine demand.

The Water Quality Act of 1965 requires chlorination of all waste water effluents which exceed maximum allowable limits for coliform. The most important function of chlorination of waste water is disinfection and ultimate destruction of pathogenic bacteria, virus, and amoeba. Other benefits of chlorination are odor control, BOD reduction, corrosion control, grease removal and control, control of psychoda flies and trickling filters, control of trickling filter ponding, control of activated sludge bulking, thickening of waste activated sludge, and prevention and removal of bacterial slime growths. Odor control is effected by reaction of chlorine with H<sub>2</sub>S to precipitate sulfur. However, less chlorine is required to kill the H<sub>2</sub>S producing organisms. Therefore, prevention of odors are more economical than remedial action. BOD reduction in the range of 15% to 35%, with an average of 20% to 25%, can be expected with 0.2-0.5 ppm orthotolidine residual after 10 minute contact. Corrosion control is also effected by elimination of H<sub>2</sub>S before it reacts to form sulfuric acid. Grease removal is obtained by prechlorination at 2-5 ppm. Psychoda flies can be killed by weekly applications of 3-10 ppm chlorine. (See also W71-03819) (Makela-Texas)

W71-03825

#### LABORATORY TECHNIQUES FOR DISSOLVED AND SUSPENDED SOLIDS: TOTAL, VOLATILE, AND FIXED, Oklahoma State Univ., Stillwater.

Patricia J. Turner.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 61-70. 4 ref, 3 tab.

Descriptors: \*Analytical techniques, \*Dissolved solids, Laboratory tests, Waste water treatment, Solid wastes.

Identifiers: \*Suspended solids.

The purpose of laboratory work is to collect data which can be practically applied to a water pollution control program. Accuracy and neatness in technique are most important. Consistency in sample is also much desired. The author recommends a properly refrigerated 24 hour composite sample for use in dissolved and suspended solids determination. The author also gives a step by step outline of the procedure to follow in determining total, volatile, and fixed dissolved and suspended solids. A commentary on important points accompanies this procedure. Both dissolved and suspended solids tests are based on a loss in weight due to precise temperature drying. An accurate weight must be determined by a consistent method, and a constant weight must be reached at every drying point. With practice, this technique can be used by any waste water treatment plant operation to check the efficiency of operation of each treatment unit in the plant. (See also W71-03819) (Makela-Texas)

W71-03826

#### WATER WORKS RECORD KEEPING, Oklahoma State Univ., Stillwater.

B. J. Bourlon.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 71-81.

Descriptors: \*Costs, Operation and maintenance, Budgeting, Cost allocation, Cost analysis, Personnel management, Waste water treatment.

This article briefly states the reasons for keeping records in a municipal Water and Waste Water Treatment Department. Records serve as a data source for analysis, planning, and control. Records can be kept in three main areas; progress, planning, and budget support. Records should be simple, clear, concise, and should contain all necessary and pertinent data. Unused records are a waste of time and money. Records can be kept in many activities, including the following which are discussed in some detail: activity expenditure control which covers cost controls in personnel services, maintenance and operation, contractual services, and capital outlays; time studies which yield comparison records of times for use in judging the efficiency of operation of employees and procedures; personnel records, both background and on-the-job; research and development; job analysis and work orders, which enable the determination of efficiency of man-hours and materials; maintenance records; production records; laboratory analysis records on water quality tests, etc. One of the most important uses of records lies in the area of budget preparation. (See also W71-03819) (Makela-Texas)

W71-03827

#### OPERATION AND MAINTENANCE OF A PRIMARY CLARIFIER, Oklahoma State Univ., Stillwater.

B. J. Bourlon.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 82-92.

Descriptors: \*Sewage treatment, Operation and maintenance, \*Settling basins, Sedimentation, Settling velocity, Waste water treatment.

Identifiers: \*Primary treatment, \*Clarifiers.

## Ultimate Disposal of Wastes—Group 5E

The purpose of primary treatment is to remove settleable solids from sewage and to prepare the solids for disposal. A plain settling basin involves only solids settling and collection. Solids treatment occurs elsewhere. A multipurpose basin involves both settling and sludge treatment. Multipurpose basins are usually designated as septic tanks, or in one modification, as an Imhoff tank. This article discusses briefly several features of importance to primary clarification. Subjects discussed include: factors affecting sedimentation, short circuiting, inlet and outlet structures, features of plain primary clarifiers, efficiency of plain primary clarifiers, sludge withdrawal, maintenance of primary clarifiers, performance expected, and record keeping. For example, a plain settling tank, under normal operation on raw domestic sewage, should remove 90 to 95% of the settleable solids, 40 to 60% of suspended solids and 30 to 40% of the BOD; and it should concentrate the sludge to a moisture content of 93 to 96%. (See also W71-03819) (Makela-Texas)  
W71-03828

#### STABILIZATION POND OPERATION AND MAINTENANCE, Oklahoma State Univ., Stillwater.

Cline L. Mansur.

Proceedings of the 42nd Annual Water and Pollution Control School, Oklahoma State University, November 18-22, 1968, Stillwater (1969), p 93-102. 7 ref.

Descriptors: \*Oxidation lagoons, Operation and maintenance, \*Lagoons, \*Sewage lagoons, Sewage treatment, Waste water treatment.

Waste stabilization ponds provide a high degree of treatment with a minimum of maintenance and operational expense, yet, because these ponds can operate with surprisingly little attention, maintenance and operational requirements are often neglected. The purpose of this paper is to present some guides to operations and maintenance of waste stabilization ponds. The author first defines a waste stabilization pond and its potential classification as aerobic, anaerobic, or facultative. The functions of aerobic, anaerobic, and facultative bacteria and algae are discussed with respect to waste stabilization ponds. Assuming proper pond design, the operator's goal is to provide favorable conditions for algae and bacterial growth. At start up, it is helpful to add commercial fertilizer at a rate of 200 lbs per acre. The design water depth should be maintained to allow the most efficient relationship between time-detention capabilities and algae-sunlight-oxygen capabilities. Special releases should be made during periods of heavy rainfall or high water flow. Weeds and floating scum should be removed weekly. An operation schedule and seasonal check list for assistance in operation and maintenance of the lagoon is given, and the use of several ponds in parallel, or in series, or in combination is discussed with the viewpoint of maximum efficiency at various times of operation. (See also W71-03819) (Makela-Texas)  
W71-03829

#### 5E. Ultimate Disposal of Wastes

##### MICROBIOLOGY OF SEWAGE LAGOONS-ROLE OF PURPLE SULFUR BACTERIA IN STABILIZATION OF INDUSTRIAL WASTES, North Dakota Water Resources Research Inst., Fargo.

For primary bibliographic entry see Field 05D.  
W71-03301

##### SUBSURFACE DISPOSAL OF LIQUID WASTES IN ONTARIO,

D. D. McLean.

Ontario (Canada) Department of Energy and Resources Paper 68-2, December 1968. 91 p, 23 fig, 2 tab, 95 ref, 2 append.

Descriptors: \*Waste disposal, \*Injection wells, Industrial wastes, Waste water disposal, Hydrogeology, Aquifers, Confined water, Aquiclude, Geology, Permeability, Water chemistry, Water quality. Identifiers: \*Canada, \*Waste disposal wells, \*Ontario (Canada).

Ontario, as a site for subsurface disposal of wastes, is discussed in relation to its specific geological and hydrological features, with regard to their suitability for disposal, and the policies and requirements of its regulatory agencies. The proposed disposal formation must be a uniform sandstone, limestone or dolomite aquifer, large in area and cross-section, with high porosities and permeabilities. The formation must be well below fresh water horizons and be contained by overlying and underlying impermeable strata. A salt water filled formation, artesian in nature, and containing no waters of economic value should be employed. The fluids present must be compatible with the ones to be injected. The region surrounding a proposed disposal well must be studied to ascertain whether there are any unplugged wells which penetrate the formation, or whether there is evidence of fractures or faults. Equations were developed for ideal conditions which permit accurate predictions of well performance, dispersion of waste and pressure buildup. The well must be constructed in such a manner as to protect all other horizons and to confine the waste to the disposal formation. It is essential that any disposal operation be monitored. (Knapp-USGS)  
W71-03438

##### ULTIMATE DISPOSAL OF PHOSPHATE FROM WASTE WATER BY RECOVERY AS FERTILIZER,

Grace (W. R.) and Co., Clarksville, Md.  
For primary bibliographic entry see Field 05D.  
W71-03459

##### ULTIMATE DISPOSAL OF ADVANCED-TREATMENT WASTE, PART 1. INJECTION, PART 2. PLACEMENT IN UNDERGROUND CAVITIES, PART 3. SPREADING, Louis Koenig-Research, San Antonio, Tex.

L. Koenig.

Available from NTIS as PB-168 796, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-8, Advanced Waste Treatment Research Program, US Public Health Service, Robert A Taft Sanitary Engineering Center, May 1964. 146 p, 22 fig, 31 tab, 78 ref. FWPCA Project 17070--05/64.

Descriptors: \*Waste water treatment, \*Economics, \*Injection, \*Underground storage, Water reuse, Waste water disposal, Waste disposal. Identifiers: Spreading, \*Ultimate disposal.

Cost estimates are made for ultimate disposal by injection to underground formation, placement in underground cavities and spreading, of the contaminants resulting from complete renovation of a municipal waste water. For injection, the process parameters were concentration of contaminants and daily volume taken respectively as 300,000, 9,000 and 300 ppm total organic and inorganic contaminants, and 1,000, 100,000 and 10 million gpd. These costs varied from \$0.13 to \$27 per 1,000 gallons injected (7,000 ft, 260 psi wellhead pressure, 1.187 fluid density) as the capability decreased from 2 million to 1,000 gpd. Cost is relatively independent of concentration and is very much cheaper than wet oxidation. For injection into cavities mined by conventional methods, fixed costs alone vary from \$243 to \$72 per 1,000 gallons at capabilities of 1,000 and 10 million gpd, respectively. Spreading is by far the cheapest method. Costs varied from \$0.30 to \$0.001 per 1,000 gallons as the capability varied from 1,000 (0.4-foot-per-day infiltration rate) to 10 million gpd (4.0-foot-per-day infiltration rate). Land costs had very little effect on over-all cost. Costs are 1 percent or less of other methods investigated, but spreading is severely limited because of potential groundwater pollution. (Selby-Texas)

W71-03513

##### ULTIMATE DISPOSAL OF ADVANCED-TREATMENT WASTE, PART 1. WET OXIDATION, PART 2. INCINERATION, Louis Koenig-Research, San Antonio, Tex.

L. Koenig.

Available from NTIS as PB-168 977, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Health Series AWTR-3, Advanced Waste Treatment Research Program, Public Health Service, Robert A Taft Sanitary Engineering Center, October 1963. 78 p, 19 fig, 11 tab, 49 ref. FWPCA Project 17070--10/63.

Descriptors: \*Waste water treatment, \*Economics, \*Incineration, Oxidation, Waste water disposal, Waste disposal. Identifiers: \*Wet oxidation, Advanced waste treatment.

Cost estimates are made for ultimate disposal, by wet oxidation (Zimmerman Process) and incineration, of the concentrated contaminants resulting from complete renovation of a municipal waste water. For wet oxidation, nine hypothetical cases covered the flow ranges from 1,000 to 10 million gpd and organic contaminant concentration ranges from 100 to 100,000 ppm. Plant costs vary from \$4 to \$80 per gallon of concentrate per day capacity (10,000,000 to 1,000 gallons per day). Operating costs vary from \$1.40 to \$35 per thousand gallons of feed. Pre-evaporation could reduce costs. Fixed costs constitute a large proportion of total costs. A theory of the reaction mechanism is proposed. For incineration, consideration was given to the Atomized Suspension Technique, a box furnace flash dryer-Nichols Herreshoff furnace combination, and three processes under development for calcination of nuclear wastes. Estimates of pre-evaporation to 30% solids and hauling of ash were included. A flash dryer-Nichols Herreshoff furnace combination was selected. Costs per 1,000 gallons of concentrate varied from \$0.57 (10,000,000 gallons per day, 300 ppm) to \$68 (1,000 gallons per day, 300,000 ppm). Corresponding unit investment costs were \$1.53 and \$108 per gallon per day capacity. (Selby-Texas)  
W71-03514

##### POND LININGS FOR DESALTING PLANT EFFLUENTS.

Bureau of Reclamation, Denver, Colo. Div. of Research.  
For primary bibliographic entry see Field 05G.  
W71-03523

##### MISSION IMPOSSIBLE: DISPOSE ANIMAL WASTES, Ohio State Univ., Columbus. Dept. of Agricultural Engineering.

For primary bibliographic entry see Field 05D.  
W71-03569

##### POLLUTION, PROPERTY AND PRICES, Toronto Univ., (Ontario).

For primary bibliographic entry see Field 06C.  
W71-03630

##### DEEP WELL DISPOSAL STUDY FOR BALDWELL, ESCAMBIA AND MOBILE COUNTIES, ALABAMA.

Geological Survey of Alabama, University.

Available from NTIS as PB-194 336, \$3.00 in paper copy, \$0.95 in microfiche. Circ-58, June 1970. 79 p, 8 fig, 10 plates, 15 ref. HUD Project Ala P-63 (G).

Identifiers: \*Waste disposal, \*Injection wells, \*Water pollution, \*Industrial wastes, \*Alabama, Water pollution, Deep wells, Sedimentary rocks, Groundwater, Porosity, Stratigraphy, Permeability, Construction, Liquids, Chemical reactions. \*Baldwin County (Alabama), \*Escambia County (Alabama), \*Mobile County (Alabama), \*Water pollution control.

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5E—Ultimate Disposal of Wastes

Baldwin, Escambia, and Mobile Counties have a combined area of 3,817 square miles and a population of 396,900 (1960 census). The area encompasses the highly industrialized Mobile metropolitan area and the port of Mobile. The area of study is underlain by sedimentary rocks of the type used as reservoirs for waste disposal in other parts of the United States. Under certain geologic, hydrologic, and geochemical conditions it is believed that deep-well injection of liquid industrial waste can be carried out effectively in southwest Alabama. Each proposal, however, must be carefully evaluated, using the criteria outlined in this report to insure against pollution of fresh-water supplies, surface and ground, and protect against damage to the environment in the subsurface or at the surface.

W71-03766

**INDIVIDUAL WASTE DISPOSAL SYSTEMS,**  
Connecticut Univ., Storrs.  
For primary bibliographic entry see Field 05D.  
W71-03774

**SLUDGE HANDLING AND DISPOSAL,**  
Tennessee Dept. of Health.  
For primary bibliographic entry see Field 05D.  
W71-03824

### 5F. Water Treatment and Quality Alteration

**REPORT ON WATER AND WASTE WATER FOR BROWARD COUNTY, FLORIDA.**  
Affiliates of Florida, Inc., Miami. Broward County Area Planning Board, Fort Lauderdale, Fla.  
For primary bibliographic entry see Field 05D.  
W71-03532

**THE ISOLATION OF PROTOZOA AND ALGAE FROM THEIR BACTERIAL CONTAMINANTS,**  
Massachusetts Univ., Waltham. Dept. of Environmental Sciences.  
Robert A. Coler, and Haim B. Gunner.  
Phyton, Vol 26, No 2, p 191-194, November 1969.  
3 fig, 11 ref. OWRR Project A-020-MASS (3).

Descriptors: \*Isolation, \*Bacteria, \*Protozoa, \*Algae, Lethal limit, Electrophoresis, Microorganisms, Electric currents, \*Waste treatment, Waste water treatment.

A technique is outlined for the isolation of ciliated protozoa and green and blue-green algae from bacteria. The procedure is designed to exploit both the electrophoretic mobility of selected ciliated protozoa and flagellated algae and the apparently greater vulnerability of bacteria over protozoa and algae to the lethal effects of an electric field.

W71-03775

**WATER AND WASTE WATER SYSTEMS TO COMBAT CHOLERA IN EAST PAKISTAN,**  
Rader and Associates, Miami, Fla.  
For primary bibliographic entry see Field 05D.  
W71-03814

### 5G. Water Quality Control

**MANIPULATION OF RESERVOIR WATERS FOR IMPROVED QUALITY AND FISH POPULATION RESPONSE,**  
Wisconsin Dept. of Natural Resources, Madison.  
Thomas L. Wirth, Russell C. Dunst, Paul D. Uttermann, and William Hilsenhoff.  
Available from NTIS as PB-196 662, \$3.00 in paper copy, \$0.95 in microfiche. Wisconsin Department of Natural Resources, Madison, Research Report No 62, 1970. 23 p, 2 fig, 7 ref. OWRR Project B-013-WIS (4).

Descriptors: \*Aeration, Dissolved oxygen, \*Hypolimnion, \*Nutrients, Plankton, \*Epilimnion, \*Eutrophication, Water temperature, Wisconsin, Water pollution control, Water quality.  
Identifiers: \*Reservoir management, Cox Hollow Lake (Wisc), Twin Valley Lake (Wisc).

Compressed air continuously mixed Cox Hollow Lake, an 8-year-old eutrophic reservoir, for 3 years. Winter D.O. levels were greatly improved. The elimination of severe thermal stratification in summer resulted in: (1) considerable warming of deep water, (2) disappearance of high chemical concentrations near the bottom and recurrence of D.O., (3) habitation of profundal muds by invertebrates. There were no lasting improvements in water clarity or in several fish population parameters by the end of the study, although there was an increase in fish harvest. Eutrophication prevention by continual bottom-water discharge was studied in newly formed Twin Valley Lake. The hypolimnion was anaerobic during the summer resulting in high chemical concentrations. Large amounts of N and P were released, exceeding the potential amount for an epilimnion discharge; however, eutrophication was soon exemplified in high plankton densities and overabundant rooted vegetation. By the second fall the fish population exhibited signs of developing into a lower quality fishery. In the downstream channel warmer water in winter and colder water in summer benefited the growth and survival of stocked brown trout. Although the stream environment was still unsettled after three years, it was improved greatly. (See also W71-03308)  
W71-03307

**SOME EFFECTS OF HYPOLIMNITIC DISCHARGES ON TEMPERATURES IN THE STREAM BELOW,**  
Wisconsin Univ., Madison. Water Resources Center.

Paul D. Uttermann.  
Supported in part by Wisconsin Dept. of Natural Resources. Available from NTIS as PB-196 663, \$3.00 in paper copy, \$0.95 in microfiche. Technical Report, Water Resources Center, University of Wisconsin, Madison, 1970. 34 p, 7 fig, 2 tab, 5 ref. OWRR Project B-013-WIS (5).

Descriptors: \*Temperature, \*Streams, \*Dams, \*Impoundment, \*Hypolimnion, Downstream, Lakes, Discharge (Water), Mathematical studies, Wisconsin.

Identifiers: Hypolimnitic-discharges, Temperature modification, Mill Creek (Wisc), Twin Valley Lake (Wisc).

Temperature modification in streams as a result of hypolimnitic-discharges from impoundments is investigated from both an analytical viewpoint and a case study. A one-dimensional mathematical-analysis of stream temperatures as affected by hypolimnitic discharges is outlined and the interrelationships of stream depth, flow velocity, discharge temperature, and normal stream temperatures are discussed. There are three types of temperature effects that may occur depending on the time of year and the characteristics of the impoundment. Compared to those temperatures which would have occurred in the absence of the impoundment, maximum diurnal temperatures are reduced at all points in the downstream channel only when the discharge temperature is lower than the normal minimum diurnal temperature. Hypolimnitic discharges are also likely to increase the diurnal temperature fluctuation at points in the stream below. A technique is presented by which the general temperature changes which are likely to occur as a result of hypolimnitic discharges may be estimated. Although the technique has not been tested sufficiently to judge its general merit, it provides a reasonable description of the changes observed in Mill Creek. (See also W71-03307)  
W71-03308

**SOME CONSIDERATIONS FOR WATER QUALITY AND ENVIRONMENTAL PROTECTION IN WILD AND SCENIC RIVER DEVELOPMENT: THE CHATTOOGA RIVER - A CASE STUDY,**  
Forest Service (USDA). Southern Region.  
Daniel D. Bacon.

In: Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ Water Resources Research Institute, p 135-143, 1970. 9 p, 2 fig, 2 map, 3 tab, 4 ref. OWRR Project A-999-MISS (6).

Descriptors: \*Water quality, \*Water pollution sources, \*Wild rivers, \*Water pollution control, North Carolina, South Carolina, Georgia, Sewage disposal, Sewage treatment, Recreation, Scenery, Turbidity, Sediment yield, Wild river act.  
Identifiers: \*Chattooga River (NC-SC-Ga).

The Chattooga Wild and Scenic river (NC, SC, and Ga) study included study of water quality. The Chattooga River begins on the crest of the Blue Ridge in North Carolina. It flows southward for 10 miles in North Carolina, then continues for 40 miles as a boundary between the states of South Carolina and Georgia. About 90% of the watershed area is in forest, mostly mixed pine-hardwood type. The other 10% is in general type farms including some pasture, row crops, and orchards, the urban area of Clayton, Georgia, and roads. Raw water quality is excellent for most parameters tested on the entire river and all its tributaries except the river below Stekoa Creek and Stekoa Creek proper. Poor quality on Stekoa Creek and below Stekoa Creek in the main river was due primarily to a municipality emptying raw sewage into the creek. The municipality is presently constructing a modern sewage treatment plant which should alleviate this condition. The other parameter that shows poor water quality is the high turbidity for short periods following runoff producing storms. Better conservation practices on agricultural land, forest land, and roads, would keep the soil in place rather than in the stream. (See also W71-03380). (Knapp-USGS)  
W71-03388

**WATER MANAGEMENT RESEARCH GROUP: FIRST REPORT (1969).**  
Organization for Economic Co-Operation and Development, Paris (France).  
For primary bibliographic entry see Field 06A.  
W71-03445

**DEVELOPMENT OF A PORTABLE PILOT PLANT TO DEMONSTRATE REMOVAL OF CARBONACEOUS, NITROGENOUS, AND PHOSPHORUS MATERIALS FROM ANAEROBIC DIGESTER SUPERNATANT AND SIMILAR PROCESS STREAMS,**  
FMC Corp., Santa Clara, Calif. Central Engineering Labs.

For primary bibliographic entry see Field 05D.  
W71-03453

**NEW MINE SEALING TECHNIQUES FOR WATER POLLUTION ABATEMENT.**  
Halliburton Co., Duncan, Okla.

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Price \$1.50. I67, 13/4: 14010 DMO 03/70. Available from NTIS as PB-196 736, \$0.95 in microfiche. Water Pollution Control Research Series 14010 DMO-03/70, March 1970. 163 p, 31 tab, 66 fig, 3 ref. append. FWPCA Program No. 14010 DMO, Contract No. 14-12-453.

Descriptors: \*Pollution abatement, Water pollution control, \*Mining engineering, \*Acid mine water, West Virginia, \*Grouting, Cement, Aggregates, Cement grouting.  
Identifiers: \*Mine sealing.

## Water Quality Control—Group 5G

The purpose was to develop and field test new concepts for watertight mine seal and bulkhead construction applicable to abatement of acid mine water pollution. Laboratory research determined proper materials, equipment and techniques for constructing mine seals or bulkheads. Field testing was conducted on remedial grouting techniques for constructing mine seals or bulkheads. Two new processes were developed. One involved a technique of placing a plug of graded limestone aggregate in a mine drift or portal to neutralize an acid mine water discharge until a seal was effected. In the process, precipitation of iron hydroxide gradually closed the pores. A pneumatic conveying technique permitted placement of up to 550 pounds per minute of aggregate into a mine drift. The second process consisted of remotely constructing a mine seal including rear and front bulkheads of a self-supporting, quick-setting sodium silicate cement specifically developed for this application. A filler material of expansive cement was used between the bulkheads to complete the seal. Field testing in West Virginia substantiated the feasibility of both processes when two aggregate and two bulkhead type seals were placed in abandoned mines which had drainage flows up to 58 gallons per minute. Cost of the seals are reported.

W71-03456

## NUCLEAR POWER STAGES COMEBACK,

Chemical and Engineering News, Volume 48, No 47, p 48-51, November 9, 1970. 1 fig, 1 tab.

Descriptors: \*Nuclear power plants, \*Electric power industry, Desalination plants, \*Natural gas, Oil, Tennessee Valley Authority Project.

Identifiers: \*Fossil fuel, Monticello nuclear plant.

This article discusses the future of nuclear power plants as compared with fossil-fuel power plants. Scarcity of fossil fuels, their rising cost and problems of air pollution from burning them have caused a turn-around in the outlook for nuclear power. The coal shortage may be worse than at first suspected, due to the fact that only a fraction of the reserves are economically accessible. To a lesser degree the status of the fuel oil supply is similar to that of coal. The same is true of natural gas. In sharp contrast is nuclear fuel, current exploration program has nearly doubled prime reserves of U<sub>3</sub>O<sub>8</sub>, the most abundant nuclear fuel raw material. Three fundamental reasons for the expected dominance of nuclear power are: low unit cost, its portability, and the small volume of effluents from nuclear plants compared with fossil fuel plants. The principal use of nuclear power in the future, other than electrical power generation, is sea water desalination. The multipurpose plant or nuclear complex (nuplex) will permit the thermodynamic potential of high temperature steam to be used for power generation and the lower-quality heat for distillation and heating. (Herrera-Vanderbilt)

W71-03463

## POND LININGS FOR DESALTING PLANT EFFLUENTS.

Bureau of Reclamation, Denver, Colo. Div. of Research.

W. R. Morrison, R. A. Dodge, J. Merriman, and L. M. Ellsperman.

Sold by Supt. of Documents, U. S. Government Printing Office, Washington, D.C. 20402 Price \$1.00. Office of Saline Water Research and Development Progress Report No 602, September 1970. 114 p, 13 fig, 37 tab, 11 photos, 14 ref, 4 append. OSW Contract 14-01-0001-1306, W.O. 3.

Descriptors: \*Brine disposal, \*Ponds, \*Desalination, Seepage, \*Linings, \*Effluents.

Identifiers: \*Soil Sealants, Polyvinyl chloride, \*Solar Ponds, Permeability tests, Desalting Plant, Asphaltic concrete, Earth linings, Flexible linings.

A field and laboratory evaluation of lining materials proposed for use in brine disposal ponds was conducted. Flexible membrane linings were the

most effective for seepage control, followed by hard-surface linings, compacted earth, and soil sealants. The investigation and other studies show that soil sealants only reduce seepage and do not affect a complete seal, and that the service life of soil sealants is questionable. Recommendations on a monitoring system for measuring seepage losses from brine disposal ponds are included. (Morrison-Office of Saline Water)

W71-03523

## SOILS AS AN ANIMAL WASTE DISPOSAL MEDIUM,

Minnesota Univ., St. Paul. Dept. of Soil Science.

William P. Martin.

Journal of Soil and Water Conservation, Vol 25, p 43-45, March-April 1970. 18 ref.

Descriptors: \*Farm wastes, \*Sails, Nitrogen, Phosphorous, Potassium, Soil water, Water pollution, Soil contamination, Soil surveys, Nutrients, Fertilizers, Soil properties, Value, Soil chemical properties, Soil physical properties, Soil erosion, Sedimentation, Minnesota.

Identifiers: Waste disposal medium.

Pollution of the soil-water complex occurs mostly because we have no other medium for waste disposal. The author discusses the various reactions which can be expected in soil with respect to nitrogen, phosphorous and potassium. The importance of erosion and sedimentation control is also pointed out. It was stressed that considerable additional information is needed if we are to maximize the use of the soil as a waste disposal medium in such a way as to minimize pollution. We must manage our natural resources to accomodate our waste disposal needs with a minimum of pollution and still produce nutritious food in adequate amounts for our rapidly increasing population. (White-Iowa State)

W71-03536

## RAISING LIVESTOCK IN THE URBAN FRINGE,

Iowa State Univ., Ames. Dept. of Agricultural Engineering.

J. Ronald Miner.

Agricultural Engineering, Vol 51, No 12, p 702-703, December 1970.

Descriptors: \*Odor, \*Pollution abatement, Farm wastes, Pollutants, Legal aspects, Livestock, Planning management.

Identifiers: Urban-fringe.

More people in this country demand more and better-quality livestock production. However, the population is extremely sensitive to water and air quality. The livestock producer should recognize that there will soon be no livestock production area where environmental pollution is acceptable. All livestock production enterprises must be planned as though they will operate in the urban fringe. Livestock production units can and do cause pollution of the air and waterways if improperly managed. The most frequent complaint leveled at urban-fringe livestock production is that of odors. Through proper design and management the livestock operations may be made acceptable to the public. (Christenbury-Iowa State)

W71-03539

## RELATIONSHIP OF AGRICULTURE TO SOIL AND WATER POLLUTION.

Cornell Univ., Ithaca, N.Y.

For primary bibliographic entry see Field 05B.

W71-03542

## LEGAL RESTRAINTS ON AGRICULTURAL POLLUTION,

Virginia Polytechnic Inst., Blacksburg. Water Resources Research Center.

William R. Walker.

In: Relationship of Agriculture to Soil and Water Pollution; Proceedings, Cornell University Conference on Agricultural Waste Management, Rochester, January 19-21, 1970, Ithaca, 1970, p 233-241. 31 ref.

Descriptors: \*Water pollution, \*Farm wastes, Water Quality Act, Legislation, Discharge, Pesticides, Riparian rights, Odors, Zoning.

Identifiers: \*Agricultural pollution, \*Common law, State regulations, Federal regulations, Equity, Trespass, Liability, Nuisance, Negligence, Strict liability.

The basis is discussed for recovery under common law for agricultural pollution. These include actions for trespass, nuisance, negligence, and strict liability. However, agricultural pollution is not likely to be effectively controlled with private litigation. The federal government has the necessary legislation to play a leading role in agricultural water pollution abatement and it is designed to encourage the states to take a more aggressive role. Public awareness of the seriousness of the pollution problem in general is ever increasing. State laws banning the use of DDT, and HEW decisions to phase out the use of some of the persistent pesticides would indicate that public pressure for action in the field of agricultural pollution will be increasing. Thus there would seem to be little doubt that the law has a continuing and expanding role to play if agricultural pollution is to be controlled. (See also W71-03542) (White-Iowa State)

W71-03552

## A NOTE ON THE UTILISATION BY CHICKENS OF ENERGY FROM FAECES,

Queensland Univ., Brisbane (Australia). Dept. of Animal Husbandry.

For primary bibliographic entry see Field 05D.

W71-03583

## ANNUAL REPORT 1970 DELAWARE RIVER BASIN COMMISSION.

Delaire River Basin Commission, Trenton, N.J.

For primary bibliographic entry see Field 06B.

W71-03592

## INDUCED OXIDATION OF STREAMS AND WATER QUALITY CONTROL INSTITUTIONS,

Rutgers - The State Univ., New Brunswick, N.J.

Water Resources Research Inst.

William Whipple, Jr., Frank W. Dittman, and Shaw L. Yu.

Water Resources Bulletin, AWRA, Vol 6, No 6, p 968-979, December 1970. 1 fig, 14 ref.

Descriptors: \*Aeration, \*BOD, \*Optimization, \*Dissolved oxygen, \*Water quality control, Oxygen sag, Water Pollution treatment.

Identifiers: \*Instream aeration, \*Induced oxidation, \*Oxygen dispersers.

The proof is rapidly mounting that instream aeration is a technically and economically feasible supplement to secondary treatment of wastes, an alternative to tertiary waste treatment. Some phenomena remain unexplained; and competing technologies, especially those employing molecular oxygen, are being explored vigorously. However, there are convincing arguments in favor of aeration on theoretical grounds, proved technology is available; and the first installations have already been made. While remaining questions are being further investigated, it is time to consider in more detail the broader aspects, as to the institutional, legal, and political hurdles to be overcome before advantage can be taken of the new technology. This paper first summarizes the state-of-the-art as far as technology is concerned; and then outlines the institutional problem. (Whipple-Rutgers)

W71-03593

## WATER QUALITY ENVIRONMENT AS RELATED TO INDUSTRY,

Great Western Sugar Co., Denver, Colo.

## Field 05—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5G—Water Quality Control

For primary bibliographic entry see Field 06B.  
W71-03604

#### WATER POLLUTION CONTROL AND ABATEMENT.

Iowa State Univ., Ames; Iowa Univ., Iowa City.

Ames, Iowa State University Press, Wilbrick, Ted L. and Hines, N. William, editors, 1965. 194 p.

Descriptors: \*Water pollution, \*Water quality, \*Economic evaluation, Engineering, Water law, Waste water, Municipal water, Industrial water, Agriculture, Recreation, Sewage, Government, Water use, Waste disposal, Economic analysis.

Identifiers: \*Iowa, Pollution control agencies.

This book is the result of the Iowa Water Resources Pollution Control and abatement seminar held at Iowa State University on November 9-11, 1965. The first part presents the water pollution problem as seen through the specialized vision of four different disciplines: engineering, economics, law and political science. The second part contains papers dealing with the present water pollution, and waste water disposal situations in the state of Iowa. The last section deals with the interest groups most often involved in conflicts over pollution issues: municipalities, industry, agriculture interests and outdoor recreation. (See also W71-03611 and W71-03612) (Murphy-Rutgers)  
W71-03610

#### SCOPE AND CHALLENGE OF THE WATER POLLUTION SITUATION,

Resources for the Future, Inc., Washington, D.C.  
Allen V. Kneese.

In: Water Pollution Control and Abatement, Ames, Iowa State University Press, 1965, p 3-12.

Descriptors: \*Water pollution, \*Government, \*Economic analysis, Water law, Taxes, Effluents, Waste water, Regional analysis, Water quality, Costs, Recreation, Optimization, Water treatment, Engineering, Rivers.

Identifiers: \*Efficient charges, Regional organizations, Externalities, Market forces.

A number of national laws exist which are concerned with federal participation in water pollution control activities. The author points out that these have been somewhat successful but that a serious problem still exists. The economic considerations involved are discussed and it is shown that the application of conventional control practices have not resulted in a balancing of costs and returns to achieve maximum benefits from an optimum system for the control of waste disposal. The paper discusses the main issues in water quality management; the determination of water quality, the dividing of the best physical system for achieving that quality and the determination of the best organizational and institutional arrangements for administering and managing water quality. The author finds that an effluent charge, weighted by the relative damaging effects of various effluents could be used to finance measures on a regional scale. In the concluding section, the role of regional organizations is discussed. (See also W71-03610) (Murphy-Rutgers)  
W71-03611

#### ECONOMICS OF WATER QUALITY,

Iowa State Univ., Ames.

John F. Timmons.

In: Water Pollution Control and Abatement, Ames, Iowa State University Press, edited by Wilbrick, Ted L., and Hines, N. William, 1965, p 33-50.

Descriptors: \*Water quality, \*Economic analysis, Maximization, Welfare economics, Costs, Water use, Water demand, Pollution, Population, Water supply, Water law, Technology, Government, Optimization, Budgets, Prices, Cost benefit analysis, Measurement.

Identifiers: \*Pollution control, Economic development, Institutions, Quality differentiation.

Water quality problems are explained within an economic framework designed for maximizing the satisfaction of human wants from the use of water. This study considers both the direct as well as derived demands for water in addition to the goods and services water helps produce. Investigation is made into the nature of and the growing demand for water and the economic dimension of water quality problems in relation to physical and structural dimensions, supply and demand characteristics, use interrelationships, and costs and benefits associated with particular uses and use methods. (See also W71-03610) (Murphy-Rutgers)  
W71-03612

#### ENVIRONMENTAL REPERCUSSIONS AND THE ECONOMIC STRUCTURE: AN INPUT-OUTPUT APPROACH,

Harvard Univ., Cambridge, Mass.

For primary bibliographic entry see Field 06A.  
W71-03622

#### ENVIRONMENTAL DISRUPTION AND SOCIAL COSTS: A CHALLENGE TO ECONOMICS,

Basel Univ. (Switzerland).

For primary bibliographic entry see Field 06A.  
W71-03623

#### THE DISTRIBUTION OF THE BURDEN OF SEWER USER CHARGES UNDER VARIOUS CHARGE FORMULAS,

McMaster Univ., Hamilton (Ontario).

For primary bibliographic entry see Field 06C.  
W71-03629

#### POLLUTION, PROPERTY AND PRICES,

Toronto Univ., (Ontario).

For primary bibliographic entry see Field 06C.  
W71-03630

#### PROBLEMS IN ACHIEVING SOIL AND WATER CONSERVATION.

National Academy of Sciences, Washington, D.C.

In: Readings In Resource Management and Conservation, Chicago, University of Chicago Press, 1965, p 516-527.

Descriptors: \*Conservation, \*Water resources, \*Soil conservation, Population, Economic evaluation, Multiple-purpose projects, Time, Technology, Benefits, Costs, Government, Uncertainty, Recreation, Dams.

Identifiers: \*Mixed objectives, Productivity, Exports, Imports, Scale of development.

In this paper an attempt is made to identify major problems which are hampering water and soil conservation efforts. The paper begins by explicitly defining the nature and meaning of conservation. It also looks at the nation's need for natural resources in the future, based upon projections of population growth, changing technology, exports and imports, and various uncertainties regarding the future. The problems stemming from the mixed objectives of resource conservation programs and the different viewpoints of many of the participants are then discussed. There is an evaluation of the conflicts which tend to arise in conservation programs, including those between major land and water uses, those arising in the practices and uncertainties of physical and biological reactions, those involved in the scale of development, and those arising from different time preferences. The last section of the paper studies how benefits and costs of conservation developments should be shared: (1) between public and private interests, (2) between individuals, (3) between private individuals and groups, and (4) between units of government. (See also W71-03631) (Murphy-Rutgers)  
W71-03634

#### COMPLEX SYSTEMS ANALYSIS OF WATER QUALITY DYNAMICS: THE FEEDBACK SYSTEMS STRUCTURE,

Georgia Inst. of Tech., Atlanta. Environmental Resources Center.

For primary bibliographic entry see Field 06A.  
W71-03731

#### AN ECONOMIC EVALUATION OF CONNECTICUT WATER LAW: WATER RIGHTS, PUBLIC WATER SUPPLY AND POLLUTION CONTROL,

Connecticut Univ., Storrs. Inst. of Water Resources.

For primary bibliographic entry see Field 06B.  
W71-03732

#### MAINE LAW AFFECTING MARINE RESOURCES, VOLUME III: REGULATION OF THE COAST: LAND AND WATER USES.

Maine Univ., Portland. School of Law.

For primary bibliographic entry see Field 06E.  
W71-03785

#### LAW AND THE ENVIRONMENT.

For primary bibliographic entry see Field 06E.  
W71-03792

#### OUTLINE OF FEDERAL ENVIRONMENTAL LAW FOR THE PRACTICING LAWYER,

For primary bibliographic entry see Field 06E.  
W71-03794

#### THE RIGHT TO A DECENT ENVIRONMENT: PROGRESS ALONG A CONSTITUTIONAL AVENUE,

For primary bibliographic entry see Field 06E.  
W71-03796

#### THE SANTA BARBARA OIL SPILL,

For primary bibliographic entry see Field 06E.  
W71-03798

#### OUR WATERS AND WETLANDS: HOW THE CORPS OF ENGINEERS CAN HELP PREVENT THEIR DESTRUCTION AND POLLUTION.

House Comm on Gov't Operations. Committee on Government Operations (U. S. House).

For primary bibliographic entry see Field 06E.  
W71-03802

#### WATER FOR ILLINOIS - A PLAN FOR ACTION.

Illinois State Technical Advisory Committee on Water Resources, Springfield.

For primary bibliographic entry see Field 04A.  
W71-03806

#### RESTORING THE QUALITY OF OUR ENVIRONMENT.

President's Science Advisory Committee, Washington, D.C. Environmental Pollution Panel.

For primary bibliographic entry see Field 06E.  
W71-03807

## 06. WATER RESOURCES PLANNING

### 6A. Techniques of Planning

#### STREAMFLOW GENERATING TECHNIQUES: A COMPARISON OF THEIR ABILITIES TO SIMULATE CRITICAL PERIODS OF DROUGHT,

California Univ., Los Angeles. School of Engineering and Applied Science.

For primary bibliographic entry see Field 02E.  
W71-03314

## Techniques of Planning—Group 6A

**GROUNDWATER SYMPOSIUM.**  
For primary bibliographic entry see Field 02F.  
W71-03401

**WATER MANAGEMENT RESEARCH GROUP: FIRST REPORT (1969).**  
Organization for Economic Co-Operation and Development, Paris (France).

Organization for Economic Co-Operation and Development, Ex 40101, 1970. 25 p, 6 append.

Descriptors: \*Planning, \*Project purposes, \*Water requirements, \*Watershed management, Lakes, Reservoirs, Eutrophication, Water quality, Appraisals, Water demand, Water resources, Water users, Water supply, Foreign research, Priorities, Industries, Conferences.

Identifiers: \*OECD, \*Water Management Research Group, Committee for Research Cooperation, Foreign delegates, Industrial water needs.

This memo of the Water Management Research Group (OECD) indicates five priority areas: water quality management, predictability of industrial water needs, documentation of findings, national research programs, and management of integrated river basins. The report summarizes the progress in each of these segments. The appendices incorporate details of the problems and a list of nationally nominated delegates. (Wilde-Wisconsin)  
W71-03445

**PRIORITY PROBLEMS IN WATER MANAGEMENT RESEARCH IN SOUTHERN EUROPEAN COUNTRIES.**

Organization for Economic Co-Operation and Development, Paris (France).

Organization for Economic Co-Operation and Development, Ex 40100, 1970. 9 p.

Descriptors: \*Conferences, \*Priorities, \*Planning, \*Foreign research, \*Water requirements, Water quality, Soil erosion, Desalination, Brackish water, Water costs, Flood protection, Saline water intrusion, Coastlines, Industries.

Identifiers: \*OECD, \*Committee for Research Cooperation, France, Italy, Portugal, Spain, Turkey, Yugoslavia, Mediterranean region.

This report was issued following the 1967 Barcelona meeting of the representatives of France, Italy, Portugal, Spain, Turkey, and Yugoslavia. It summarizes discussions of management problems with an emphasis on segments deserving priorities. The following problems received particular attention: soil erosion, desalination of brackish water, economy of water in industry, protection from floods, inflow of salt water into aquifers and estuaries, and coastal pollution. The participants stressed the need for management of water resources in the Mediterranean region as an essential prerequisite of economic development. (Wilde-Wisconsin)  
W71-03446

**INDUCED OXIDATION OF STREAMS AND WATER QUALITY CONTROL INSTITUTIONS,**  
Rutgers - The State Univ., New Brunswick, N.J.  
Water Resources Research Inst.

For primary bibliographic entry see Field 05G.

W71-03593

**FUNCTIONAL EVALUATION OF A WATER RESOURCES SYSTEM,**

Leo R. Beard.

The Hydrologic Engineering Center, Technical Paper No 4, Jan 30, 1967. 18 p, 2 fig, 6 tab.

Descriptors: \*Reservoir operation, Water management (Applied), Watershed management, Computer models, Computer programs, Multiple purpose reservoirs, Reservoirs, Planning, Simulation analysis.

Identifiers: \*Reservoir evaluation.

This paper describes an elaborate computer program which simulates the operation of a water resource system for conservation functions such as water supply, power generation and low flow regulation. Constraints imposed by flood control requirements are recognized, but flood control operation is not included in the program. The functional evaluation includes the determination of water and power deliveries and shortages. The program will handle multiple river basin systems with any number of reservoirs, diversions and power plants. Input data must include specifications of the system configuration, details of component capacities, inflows and evaporation. Great flexibility exists in the detail of the input data. Regular and irregular operation intervals may be simulated, and seasonal and annual variations in system requirements and controlling factors are included in the program. A computer with a large memory and high speed is required for the use of this program. (Hewett-Rutgers)  
W71-03598

**ECONOMIC FACTORS AFFECTING SYSTEM DESIGN,**  
Harvard Univ., Cambridge, Mass.  
For primary bibliographic entry see Field 06B.  
W71-03606

**THE STUDENT'S T TEST IN MULTIPLE REGRESSION UNDER SIMPLE COLLINEARITY,**

Northeastern Univ., Boston, Mass; and Baruch Coll., New York.  
Bruce Cohen, and Damodar Gujarati.  
Journal of Financial and Quantitative Analysis Vol V, No 3, p 341-351, September, 1970.

Descriptors: \*Statistics, \*Mathematical studies, \*Regression analysis, Model studies, Monte Carlo method, Correlation, Sampling, Baste-squares method.

Identifiers: \*T test, \*Multicollinearity.

The validity is discussed of the conventional t tests on regression coefficients when there is serious multicollinearity in the explanatory variable. The study attempts to show that the conventional t tests will, in practice, reflect the rise in the true standard errors of the regression coefficients due to increasing multicollinearity. The paper also points out the danger involved in mechanically dropping variables from multiple regression equations based on t tests. This danger is present because, although the t values of the regression coefficients may not be significantly different from zero, the true values of these coefficients are in fact not zero if the explanatory variables are highly intercorrelated. These results are illustrated with Monte Carlo experiments. This paper is relevant to empirical water research using correlation techniques which depend on the standard t test to establish statistical significance. (Murphy-Rutgers)  
W71-03607

**ENVIRONMENTAL REPERCUSSIONS AND THE ECONOMIC STRUCTURE: AN INPUT-OUTPUT APPROACH,**  
Harvard Univ., Cambridge, Mass.

Wassily Leontief.  
The Review of Economics and Statistics, Vol 52, No 3, p 262-271, August 1970.

Descriptors: \*Input-output analysis, \*Pollutants, Economic growth, Value added, Regional analysis.  
Identifiers: \*Environmental disruption, Externalities, Structural matrix, Input coefficient, Inversion, Final demand, Final consumption.

The incorporation of externalities such as pollutants into conventional input-output analysis is considered. Pollution is a by-product of regular economic activities and can be related in a measurable way to some particular consumption or production process. The quantitative dependence of the external output or input on the level of conventional activities is described by a technical coefficient.

ficient and incorporated in the structural matrix of the economy. Therefore, within the input-output system, any change in the output level of pollutants can be traced either to changes in final demand for goods and services, changes in technical structure or a combination of both. Through examples, the author shows the effects of a given technological change in output on pollutants and the effects of such a change on sectoral and total demand for the factor. With given value added coefficients, one can estimate the effect of such a change on prices of various goods and services. This method can be applied in a regional or sectional basis and is relevant for water resource planners. (Siegenthaler-Rutgers)  
W71-03622

**ENVIRONMENTAL DISRUPTION AND SOCIAL COSTS: A CHALLENGE TO ECONOMICS,**  
Basel Univ. (Switzerland).

William K. Kapp.  
Kyklos, Vol 23, No 4, p 833-848, 1970.

Descriptors: \*Welfare economics, \*Economic efficiency, \*Water pollution, Air pollution, Resource allocation.

Identifiers: \*Environmental disruption, \*Social costs, Externalities, Feedback effect, National accounting, Shadow price.

The ability is considered of conventional economic theory to deal with the problems of social cost and environmental disruption. Environmental disruption is defined to include man's natural and social environment. Through examples of air and water pollution, the article demonstrates that problems of environmental disruption have complex interdependences and delayed feedback effects of a non-market nature. Economic theory concentrates on and treats production, allocation, distribution, and exchange as if they occurred in a closed sphere and hence the theory often omits their effect on man's social and natural environment. Moreover, environmental disruption challenges the validity of traditional measures of efficiency and optimization. As an alternative, it is suggested that economic theory abandon its concentration on purely formal definitions of utility and efficiency and adopt an approach related to human needs and requirements in the form of interdisciplinary research. (Siegenthaler-Rutgers)  
W71-03623

**GEOMETRIC PROGRAMMING: NEW OPTIMIZATION TECHNIQUE FOR WATER RESOURCE ANALYSTS,**

Texas A and M Univ., College Station; and Texas Univ., Austin.

Wilbur L. Meir, Robert W. Lawless, and Charles S. Beightler.

In: Proceedings of the Fourth American Water Resources Conference, Commodore Hotel, New York, November 18-22, 1968, St. Anne, Illinois, Record Press, 1968, p 524-533.

Descriptors: \*Optimization, \*Cost minimization, \*Water resource development, Economic evaluation, Mathematical studies, Computers, Costs, Model studies, Planning, Systems analysis.

Identifiers: \*Geometric programming, Computer algorithm, Nonlinear programming.

The optimization technique of geometric programming is described and its adoption by the water resource analyst is recommended. This method permits the direct solution of a large class of optimization problems which were previously solved by approximating techniques. Invariance properties, which often are discovered as by-products of the solution algorithm, provide insight into the system being analyzed. The authors feel that many water resource optimization problems can be efficiently solved using this technique. The advent of computer algorithms for geometric programming holds promise to make this technique even more useful in the future. (See also W71-03625) (Murphy-Rutgers)  
W71-03627

## Field 06—WATER RESOURCES PLANNING

### Group 6A—Techniques of Planning

**READINGS IN RESOURCE MANAGEMENT AND CONSERVATION.**  
Toronto Univ., (Ontario); and Clark Univ., Worcester, Mass.  
For primary bibliographic entry see Field 06B.  
W71-03631

**THE METHODOLOGY OF WATER-RESOURCE SYSTEM DESIGN,**  
Harvard Univ., Cambridge, Mass.  
Maynard M. Hufschmidt.  
In: *Readings in Resource Management and Conservation*, Chicago, University of Chicago Press, 1965, p 558-570.

Descriptors: \*Water-resources, \*Optimization, Systems analysis, Economic efficiency, Income, Benefits, Costs, Decision-making, Technology, Investment, Demand, Economic evaluation, Government, Discount rate, Risk, Water supply, Capital costs, Rivers, Computers, Floods, Sampling, Streamflow.  
Identifiers: \*Water-resources system design, Present value, Lehigh River.

The author presents a methodology of water-resource system design for the purpose of incorporating new techniques into the planning method. Water-resource design involves application of decision-making techniques to investment problems in a systematic context and thus a workable methodology for design must be capable of dealing effectively with these attributes. The author devises a methodology with four related steps: (1) specifying the objectives of design; (2) translating these objectives into design criteria; (3) using the criteria to formulate specific designs of development and management for water-resource systems that fulfill the optimization objectives to the highest degree; and (4) evaluating the consequences of the designs which have been developed. (See also W71-03631) (Murphy-Rutgers)  
W71-03632

**COST/EFFECTIVENESS ANALYSIS: ITS TASKS AND THEIR INTERRELATION,**  
General Electric Co., Santa Barbara, Calif. TEMPO.  
David S. Fields.  
Operations Research, Vol 14, No 3, p 515-527, May-June 1966.

Descriptors: \*Systems analysis, Resource allocation, Uncertainty, Evaluation, Mathematical model, Economic efficiency, Peak load capacity, Flow, Constraint.  
Identifiers: \*Cost/effectiveness analysis, Iterative process, System characteristic, Performance model, Cost model, Feed back process.

The application of the general theory of cost effectiveness to specific systems is considered. Cost effectiveness analysis indicates how alternative design decisions are related to systems costs as a function of system effectiveness. It identifies the values of the variable characteristics to be considered in changing the system and enables the decision-maker to evaluate systems and choose the one with the preferred characteristic. After the problem is clearly stated, the tasks are to consider alternative systems, establish an evaluation basis, formulate mathematically the relationship between system costs and the characteristic models and to analyze system costs versus effectiveness. The analysis of system costs versus effectiveness indicates the tradeoff among alternative systems. A preferred value can be determined for each effectiveness level and it is the minimum cost point. Thus, the method permits the decision-maker to select the system best suited for his requirements given resource constraints. This article is relevant for water resource planners concerned with methods to evaluate investment alternatives. (Siegenthaler-Rutgers)  
W71-03654

**STATISTICAL DECISION THEORY TECHNIQUES FOR THE REVISION OF MEAN FLOOD FLOW REGRESSION ESTIMATES,**  
Carnegie-Mellon Univ., Pittsburgh, Pa.  
For primary bibliographic entry see Field 02E.  
W71-03681

**DEFINITION AND USES OF THE LINEAR REGRESSION MODEL,**  
Agricultural Research Service, Tucson, Ariz.  
Southwest Watershed Research Center.  
For primary bibliographic entry see Field 02A.  
W71-03682

**SIMULATION AND EVALUATION OF COMPLEX WATER SYSTEMS OPERATIONS,**  
Australian National Univ., Canberra.  
For primary bibliographic entry see Field 02E.  
W71-03688

**COMPLEX SYSTEMS ANALYSIS OF WATER QUALITY DYNAMICS: THE FEEDBACK SYSTEMS STRUCTURE,**  
Georgia Inst. of Tech., Atlanta. Environmental Resources Center.

John E. Knight, and William W. Hines.  
Available from NTIS as PB-196 901, \$3.00 in paper copy, \$0.95 in microfiche. Environmental Resources Center, Georgia Institute of Technology, ERC-0570, September 1970. 88 p, 25 fig, 18 ref. OWRR Project A-023-GA (1).

Descriptors: \*Water quality management, \*Water quality control, \*Water quality dynamics, \*Social impacts, \*Political constraints, \*Economic conditions, Institutional constraints, Decision making, Public attitudes, Simulation analysis, Systems analysis.  
Identifiers: \*DYNAMO simulation language.

The objective of the research was to identify and demonstrate how the management and control of water quality in a region is influenced by prevailing social, political and economic conditions and to illustrate how these prevailing conditions and attitudes interrelate in an information feedback and control system to produce traditional modes of system response. A generalized model was tested under a wide range of policies and parameters to illustrate system response and sensitivity to changes. Industrial dynamics was used to model the multi-loop, non-linear feedback system, and the DYNAMO simulation language was used to program the model for digital computer simulation, testing, and experimentation. The modeling phase isolated system variables and identified their relative magnitudes, periods and phasing in historically polluted watersheds. Different policies and parameters were tested in a refined model to determine their effect on total system response. Water quality management and control was found to be deeply embedded in a complex, information feedback system involving social, political and economic pressures and forces. The complex system response was found to be insensitive to many parameter changes and unintuitive in behavior. Some critical points were found and programs directed at these points showed significant changes in system response. (Conway-Georgia Tech)  
W71-03731

### 6B. Evaluation Process

**FACTORS AFFECTING RELOCATION IN RESPONSE TO RESERVOIR DEVELOPMENT,**  
Kentucky Water Resources Inst., Lexington.  
Rabel J. Burdge, and Richard L. Ludtke.  
Available from NTIS as PB-196 659, \$3.00 in paper copy, \$0.95 in microfiche. Partial Technical Completion Report; Project Period: January 1, 1969 - August 1, 1969, Research Report No 29, 1970. 33 p, 3 tab, 12 fig, 19 ref, append. OWRR Project A-020-KY (2).

Descriptors: \*Social change, Social aspects, \*Social impact, \*Attitudes, Social values, Kentucky, \*Rural sociology, Flood control, Reservoir.  
Identifiers: Human migration.

The focus is on the question of how rural people anticipate forced moves as a result of flood control projects and how they change their life accepting separation from familiar surroundings. A model of faced migration is presented which sees the variables of socio-economic status, knowledge of reservoir projects, vested interests and the degree of identification with place of affected persons as producing differential apprehension over moving. Differential apprehension is then seen as producing different attitudes toward the project which will influence the type of migration plans. To test this model of forced migration, data were obtained by means of personal interview with 261 adults located in two areas about to be flooded by multipurpose reservoirs. Goodman and Krushal's gamma was used as the measure of association for the ordinal data. Basic to the model were the two findings that (1) apprehension over moving relates inversely with people's willingness to separate themselves from their current friends and homes, and (2) that people with favorable attitudes toward flood control projects were less apprehensive over moving and as a consequence were more willing to engage in moves that require greater degrees of separation from their current friends and types of residences. Other findings suggest that those persons whose vested interests would be enhanced by the reservoir project can be expected to engage in moves requiring the greatest amounts of social separation. Knowledge of the reservoir project and its purposes did little to meliorate people's attitudes toward the reservoir project or to facilitate ease of moving. A new variable 'identification with place,' developed for this study, was found to relate strongly with apprehension over moving.  
W71-03304

**PRESENT HYDROLOGIC RESEARCH IN WYOMING AND FUTURE NEEDS.**  
Wyoming Univ., Laramie. Water Resources Research Inst.  
For primary bibliographic entry see Field 02A.  
W71-03306

**INTERNATIONAL ARID LANDS CONFERENCE,**  
Texas Tech Univ., Lubbock. Dept. of Agronomy.  
H. E. Dregne.  
Nature and Resources, Vol 5, No 2, p 7-12, June 1969.

Descriptors: \*Water policy, \*Arid lands, \*Conferences, \*Social aspects, \*Economics, Grazing, Social impact, Education, Planning, Water allocation (Policy), Regional analysis, Deserts, Ecology, Technology, Social needs, Economic feasibility, Economic justification, Agriculture, History, Irrigation, Mining, Institutions, Soils, Crops, Cost analysis, Mexico, Feasibility studies, Project planning, Political aspects, Research and development, United States, United Nations, Population, Crop-production, Water resources.  
Identifiers: \*Information transfer, \*Problem solving, Australia, U.S.S.R., Israel, Africa, Asia, North America, South America.

A central observation of this summary is the expansion of desert areas throughout the world because of human mismanagement. Existing arid areas have generally deteriorated in terms of soil, water and plant life. A major factor is overgrazing. Development plans in arid lands have usually involved increased water supplies for augmented agricultural production. This concept of arid land development was challenged on several grounds. (1) Construction projects receive more detailed planning and the agricultural systems they are designed to supply. (2) High intensity desert irrigation schemes require high levels of farming skills and maintenance capital. (3) Increments in per capita income resulting from agricultural development are small. (4) Tourism, mining, pastoralism, low water-

## Evaluation Process—Group 6B

use industry and other income-producers may be much more desirable. Population pressures must be alleviated or no progress will be possible. Sociological and economic factors unique to these areas, particularly education, have been neglected. The 3 separate major arid areas of the world are discussed and national and international means of attacking their problems are suggested. (Casey-Arizona) W71-03340

**PRE-IMPOUNDMENT RECREATIONAL USE PATTERN AND WATERFOWL OCCURRENCE IN THE SAYLORVILLE RESERVOIR AREA,** Iowa State Water Resources Research Inst., Ames. Arnold O. Haugen, and Richard E. Lennings.

Available from NTIS as PB-196 725, \$3.00 in paper copy, \$0.95 in microfiche. Iowa State University Water Resources Research Inst. Completion Report, June 30, 1970. 177 p, 14 fig, 95 tab, 19 ref, 3 append. OWRR Project No A-023-IA (5).

Descriptors: \*Recreation, \*Project planning, \*Reservoir design, Project purposes, Hunting, Fishing, Camping, Boating, Water resources development, Water utilization, Recreation demand, Recreation facilities, Land use.  
Identifiers: \*Recreation use surveys.

Recreation use of the proposed Saylorville reservoir area, Iowa was studied through the use of a questionnaire, two automatic time-lapse movie cameras, direct observation, and a pneumatic car traffic-counter. Results from 436 completed questionnaires indicated that fishing, motorcycling, hunting, boating and camping were the first preferred choices of outdoor recreation. Many people had no second, third, or fourth choices of preferred activity. Camping, fishing, boating, motorcycling, and canoeing, respectively, showed highest observed totals of participant-hours of activity. Seventy-six percent of all respondents (332) indicated their visits occurred on weekends. Peak numbers of people were sighted from 4 to 7 p.m. Peaks of traffic activity were observed from 3 to 5 p.m. Flat-bottomed fishing boats were the most common river craft. Almost 87% of all waterfowl using the Des Moines River in the Saylorville area during the 2 years of the study were observed during spring migration in 1969. (Knapp-USGS) W71-03373

**PROCEEDINGS MISSISSIPPI WATER RESOURCES CONFERENCE, 1970.**

Mississippi State Univ., State College. Water Resources Research Inst.  
For primary bibliographic entry see Field 04A.  
W71-03380

**REPORT ON WATER AND WASTE WATER FOR BROWARD COUNTY, FLORIDA.**

Affiliates of Florida, Inc., Miami. Broward County Area Planning Board, Fort Lauderdale, Fla.  
For primary bibliographic entry see Field 05D.  
W71-03532

**THE DISUTILITY OF UNCERTAIN LOSSES,** Rutgers - The State Univ., New Brunswick, N.J. Water Resources Research Inst.

William Whipple, Jr.  
Engineering Economist, Vol 16, No 1, p 43-57, January 1971. 2 tab, 1 fig, 19 ref.

Descriptors: \*Economics, \*Benefits, \*Risks, Cost-benefit analysis.  
Identifiers: \*Uncertainty, \*Disutility of uncertain losses, \*Utility function, Utility.

The ancient hypothesis that equal quantities of money gained or lost have different utilities depending upon the circumstances of the recipient has never been fully accepted into the main body of economic theory. To eliminate confusion, it is essential to abandon the attempt to quantify a utility function of wealth or income, and to develop in-

stead a utility function of uncertain gains contingencies by the same individuals. The basic facts of life insurance and health insurance show that the majority of persons are prepared to pay approximately twice the actuarial value to avoid major contingencies. These results allow definition of a marginal utility coefficient for this range of losses. Small losses and moderate gains apparently have utility coefficients approximating unity. A working hypothesis based upon the above is consistent with evidence as to risk aversion from the securities markets. The most important characteristic of the utility function is a high disutility of major unexpected losses, which is disproportionate to the marginal utility of gains or losses under ordinary circumstances. Application of the above conclusions provides a rational basis for an additional component of flood control benefit in some cases, and should help to clarify what has been considered an anomaly in the opportunity-cost theories of social discount rate. (Whipple-Rutgers) W71-03591

**ANNUAL REPORT 1970 DELAWARE RIVER BASIN COMMISSION.**

Delaware River Basin Commission, Trenton, N.J.  
Delaware River Basin Commission, Box 360, Trenton, New Jersey 08603, 1970. 60 p.

Descriptors: Water quality control, Estuaries, Environment, Waste treatment, Water quality, \*Delaware River, \*Delaware River Basin Commission.

Identifiers: \*Regional water quality administration, \*Regional sewerage system, \*Pollution abatement schedules.

This annual report of the DRBC contains certain items of considerable economic importance. Proposals have been made by a group of large oil companies for a large off shore loading terminal in the lower end of the Delaware estuary, in order to accommodate super tankers. This apparently feasible project (on an economic basis) has been suspended as part of a general freeze on coast line developments by the governors of New Jersey and Delaware, in the interest of environment protection. Pollution abatement schedules have been worked out with 41 large municipal and industrial waste dischargers. Generally schedules require full compliance by 1973; but the city of Philadelphia has been given more time, since in that case compliance will require expenditures of \$75 million. To serve some 30 miles of shoreline on the New Jersey side of the estuary, a regional waste treatment system is proposed. A dozen participating municipal and industrial dischargers are sharing the \$1.3 million cost of a pilot plant study, which has shown that 90% effectiveness in treating the combined wastes could be achieved. (Whipple-Rutgers) W71-03592

**LECTURES ON WATER MANAGEMENT.**

Dept. of Environmental Engineering Science, Johns Hopkins Univ., Baltimore, Md.

Water Management Seminar, October 1964-May 1965. Johns Hopkins University, Baltimore. 352 p.

Descriptors: \*Water management (Applied), Economics, Water utilization, Water resources development, Political aspects, Water law, California, Maryland, United States.  
Identifiers: Canada.

This series of twenty-four lectures covered a wide scope of topics focusing on uses of water resources and their development and management. Water resources law and politics as well as the economics of water resource development and use were dealt with by several authors. Specifically mentioned were brief case studies of the California Water Plan, the Maryland Water Supply Study and Canada - U.S. international water problems. Appropriate portions of the publication are forwarded

with abstracts of those portions. (See also W71-03595 thru W71-03596) (Holmes-Rutgers) W71-03594

**FUNCTIONAL EVALUATION OF A WATER RESOURCES SYSTEM,** For primary bibliographic entry see Field 06A. W71-03598

**WATER TRANSFERS: ECONOMIC EFFICIENCY AND ALTERNATIVE INSTITUTIONS,** Colorado State Univ., Fort Collins; and Calgary Univ. (Alberta).

L. M. Hartman, and Don Seastone. Baltimore, Johns Hopkins Press, 1970. 127 p.

Descriptors: \*Water transfers, \*Economic efficiency, \*Water law, Economic evaluation, Water supply, Districts, Computers, Water resource allocation, Income, Taxes, Government, Prices, Costs, Spillover, Irrigation, Water use.

Identifiers: \*Externalities, Colorado, New Mexico, Income effects, Water institutions.

The extent is examined to which existing organizational arrangements for the management of water resources permit reallocations to take place efficiently. The study centers on the analysis of externalities and water law. The relation between diversion and consumptive use of water transfers creates a common externality. The effect on the supply of resources to third parties is analyzed along with the conditions required for efficient transfers of water. The study also presents a comparative analysis of the performance of the Colorado and New Mexico legal systems for regulating water transfers. Other chapters report on typical organizational forms, namely, the ditch company and two different water conservancy districts. A theoretical discussion of the income interdependency effect in water transfers between communities is presented and in the concluding chapter some estimates of this effect are computed. (Murphy-Rutgers) W71-03601

**STRATEGIES OF AMERICAN WATER MANAGEMENT,** Chicago Univ., Ill.

Gilbert F. White. Ann Arbor, University of Michigan Press, 1969. 149 p.

Descriptors: \*Water management, \*Water supply, \*Planning, Irrigation, Multiple purpose projects, Floods, Municipal water, Water demand, Economic evaluation, Drainage basins, Dams, Hydropower, Regional analysis, Technology, Water quality, Costs.

Identifiers: \*Multiple means, \*Regional integration, \*Single purpose projects.

Different ways are examined in which water is and has been managed for the purpose of finding more suitable ends and means of manipulating the natural water system. The first chapter outlines a framework in which a society's water management decisions may be examined. The remainder of the book is devoted to the major strategies which have been practiced in the United States. Of these, single purpose construction is the oldest and most widespread water management strategy and the author explains how the decisions of this technique are made. This concept has developed into multiple purpose projects and multiple means. The author discusses the problems and possible solutions of determining public preferences in addition to considering the role of research in water management. The concluding chapter deals with the water management strategy of regional integration. A method of planning is developed for a metropolitan area or group of drainage basins which continually explores multiple means of reaching multiple ends. (Murphy-Rutgers) W71-03602

## Field 06—WATER RESOURCES PLANNING

### Group 6B—Evaluation Process

**WATER RESOURCE ALLOCATION, EXTRA MARKET VALUES, AND MARKET CRITERIA: A SUGGESTED APPROACH,**  
Oregon State Univ., Corvallis.  
Emery N. Castle, and Herbert H. Stoevener.  
Natural Resources Journal, Vol 10, No 3, p 532-544, July 1970.

Descriptors: \*Water resource allocation, \*Market value, Economic evaluation, Operations research, Cost-benefit analysis, Water pollution.

Identifiers: \*Public good, Externalities, Indivisibility, Consumer surplus.

The role of the market is discussed in generating information for decision makers concerned with extra-market problems. For water resources, the market has been modified or eliminated as a means of resource allocation. The reasons for the development of alternatives to the market for water resource allocation stem from a number of sources including the existence of technological interdependencies, indivisibility and the existence of water as a public good. Even when the market may fail, the logic of resource allocation which is a part of market price theory can be very valuable in the creation and the evaluation of market alternatives. The society evaluates returns relative to costs in deciding the optimal level of use. One alternative with respect to water pollution is that polluters should be charged a fee per unit for waste discharge which is economically efficient. The second example is wide scale water diversion. Operations research techniques have been used to consider possible alternatives while simulating market operations. The final example given is for outdoor recreation where research is directed one more toward simulating market criteria. (Siegenthaler-Rutgers)

W71-03603

**WATER QUALITY ENVIRONMENT AS RELATED TO INDUSTRY,**  
Great Western Sugar Co., Denver, Colo.

Lloyd T. Jensen.

In: *Man and the Quality of His Environment*, Boulder, University of Colorado Press, 1968, p 59-65.

Descriptors: \*Water quality, \*Industrial water, \*Industrial wastes, Municipal water, Prices, Costs, Water demand, Treatment costs, Pollution, Government, Taxes, Population.

Identifiers: \*Great Western Sugar Company.

The importance is outlined of adequate water resources to industrial enterprises as well as the nature of industrial water use. This need for good quality water is often in conflict with the needs of other water users and the problems of this divergence are discussed. As an example of an effective industrial program the author explains the situation of the Great Western Sugar Company which involves in-plant control of wastes, then moves to by-product recovery, then reuse, then recycling and finally treatment. There are a number of different alternatives available for water quality management which involve different prices for water due to different treatment costs. Meeting future water needs will necessitate a considerable amount of planning and will be extremely costly. (Murphy-Rutgers)

W71-03604

**ECONOMIC FRAMEWORK AND ASSOCIATED BASIC STUDIES,**  
Department of the Interior, Atlanta, Ga.  
Ned L. Williams.

In: *Organization and Methodology For River Basin Planning*, Atlanta, Georgia, Georgia Institute of Technology, 1964, p 157-185.

Descriptors: \*Water resource development, \*Economic evaluation, \*Planning, Government, Water law, Financing, Transportation, Regional analysis, Costs, Land use, Population, Investment, Agriculture, Water supply, Prices, Hydropower, River basins.

Identifiers: \*USSC, \*SERB, Econometrics, Economic studies, Migration.

The basic economic studies of the U. S. Study Commission (USSC) for the Southeast River Basins (SERB) are discussed. These studies described the present level and past trends of the SERB area and the national economy, the projected level of the economy and related growth factors, and the requirements for resource developments in a form suitable for planning future resource development programs. The paper also makes mention of other studies which provide needed insight into such considerations as water law, financing, transportation and migration. The author devotes a section to the staff organization as related to the acquisition, evaluation, presentation and use of the economic studies. The methodology of the studies is examined and the concluding section discusses the more unique, distinctive and experimental aspects of the studies. (Murphy-Rutgers)

W71-03605

#### ECONOMIC FACTORS AFFECTING SYSTEM DESIGN,

Harvard Univ., Cambridge, Mass.

Stephen A. Marglin.

In: *Design of Water Resource Systems*, Cambridge, Harvard University Press, 1962, p 159-225.

Descriptors: \*Water resources development, \*Budgets, \*Optimization, \*Investment, \*Economic evaluation, Costs, Government, Benefits, Time, Rate of discount, Interest rate, Water supply, Mathematical studies, Water demand, Planning, Prices.

Identifiers: \*Water system design, Opportunity costs, Present value.

The economic factors effecting the objectives and concepts of water system design are examined. This paper provides an analysis of the influence of the budgetary constraint, in various forms, on the optimal system design. The problems raised for system design by the dynamic nature of the investment process are treated. Since costs and benefits occur in time streams, the objective is to obtain the optimal investment schedule as well as design for system units. The choice of interest rates for public investment in water resource development is discussed and a method by which the opportunity costs of public investment can be calculated in a mixed private-public economy is provided. In the last section certain problems raised by specific external alternatives to water-resource systems are examined. (Murphy-Rutgers)

W71-03606

#### WATER POLLUTION CONTROL AND ABATEMENT.

Iowa State Univ., Ames; Iowa Univ., Iowa City.

For primary bibliographic entry see Field 05G.

W71-03610

#### SCOPE AND CHALLENGE OF THE WATER POLLUTION SITUATION,

Resources for the Future, Inc., Washington, D.C.

For primary bibliographic entry see Field 05G.

W71-03611

#### ECONOMICS OF WATER QUALITY,

Iowa State Univ., Ames.

For primary bibliographic entry see Field 05G.

W71-03612

#### PUBLIC ECONOMICS,

Stanford Univ., Palo Alto, Calif.; Paris Univ., (France).

J. Margolis, and H. Guitton.

London, Macmillan, 1969. 574 p.

Descriptors: \*Resource allocation, Risk, Optimization, Economic efficiency, Public administration, Welfare economics.

Identifiers: \*Public goods, \*Pareto criteria, Equity, Social objective function.

This book presents the papers given at a 1966 conference on Public Economics. These papers present an analysis of public production and consumption and their relations to the private sector. The central theme is the economic analysis of the public sector. The papers deal with the extension of economic theory to the public sector, the pricing and investment behavior of public enterprises and rules for their efficient operation, economic issues within public administration, and the public enterprise in a socialist setting. The economic theory papers discuss the theory of public goods and the problems of supplying the optimal amount of these services. Distributional aspects were analyzed to satisfy equity as well as efficiency conditions. The papers on pricing demonstrate that the marginal cost pricing rule is too unsophisticated to deal with the complex public enterprise. This book is relevant for water planners concerned with public goods theory and the implications of this theory for decision making criteria and resource allocation. (See also W71-03617 thru W71-03621) (Siegenthaler-Rutgers)

W71-03616

#### RISK TAKING AND RESOURCE ALLOCATION,

Institut National de la Statistique et des Etudes Economiques, Paris (France).

E. Malinvaud.

In: *Public Economics*, London, Macmillan, 1969, p 222-246.

Descriptors: \*Risk, Resource allocation, Public decision, Welfare economics, Probability distribution.

Identifiers: \*Risk aversion, Net benefit, Technical constraint, Pareto optimum, Social utility function, Present value, Capital market, Contingent goods.

The effect of risk on public decisions is discussed. The presence of risk affects the social objective to be assigned to the public allocation of resources. The social objective or norm is the maximum of the social consumption plans. The author contends that the social ethic implies that collective choices exhibit risk aversion. He then considers how risk is included in the economic calculation preceding public decision-making. Risk constitutes an extra cost and can be included through increases in the discount rate or in a security margin which increases expected costs for large risks. The result is that uncertain operations must be reduced in favor of super operations if both operations produce the same commodities but not necessarily if they produce different outputs. Public policies toward risk-taking should have three purposes: to eliminate the individual risks affecting firm management but not the community; to reduce discrepancies among evaluations of the same risks by private firms; and to ensure that private attitudes agree with social attitudes. Suggestions for future research are offered on the level of risk aversion implied for firms by the social utility function and on risk aversion. This article is relevant for water planners concerned with the role of risk in investment decision-making theory. (See also W71-03616) (Siegenthaler-Rutgers)

W71-03617

#### GENERAL EQUILIBRIUM WITH PUBLIC GOODS,

California Univ., Berkeley.

R. Dorfman.

In: *Public Economics*, London, Macmillan, 1969, p 247-275.

Descriptors: \*Welfare economics, \*Decision making, Marginal cost, Political constraint, Budget constraint, Net benefit, Marginal utility.

Identifiers: \*General equilibrium, \*Public goods, Externality, User charge, Convexity, Tax burden, Objective function, Willingness-to-pay, Citizen surplus, Concave programming, Shadow-pricing, In-

come redistribution, Consumer surplus, Social welfare function.

Public goods are ordinary economic goods except that their use can not be rationed nor can their benefits be allocated. Decisions about public goods are made socially or politically. The approach is to use a general equilibrium model to which a government sector has been added. The model assumes only socio-economic groups have preference maps for public goods. The process of gaining public acceptance for government proposals involves the persuasion of political leaders who then convey the program to their following. The model is formulated as a concave programming problem approximating government behavior given preferences, pressures and prices. The approach is that of willingness-to-pay with the government providing levels of public goods and the citizen's surplus equal to the excess of his gross benefit over the increase in taxation or burden necessitated by the increased public good consumption. It is argued that there is a price vector used by the government which brings general equilibrium in the economy. Accordingly, the level of public goods will be technically efficient. The model allows the general equilibrium theory apparatus to be used for guidance in public goods decisions and indicates the social losses occurring when decisions are not integrated with tax and expenditure policy. This article is relevant to water research activities due to its development of an explicit government sector into conventional economic models. (See also W71-03616) (Siegenthaler-Rutgers) W71-03619

#### MULTIPLE USE DECISION MAKING—WHERE DO WE GO FROM HERE, Utah State Univ., Logan.

R. S. Whaley.

Natural Resources Journal, Vol 10, No 3, p 557-565, July 1970.

Descriptors: Resource allocation, \*Decision making, Uncertainty, Economic evaluation, Cost-benefit analysis, Linear programming.

Identifiers: \*Multi-product, \*Social cost, Technical monopoly, Public welfare, Internal rate of return, Consumer surplus.

The problem of making multiple use resource allocation decisions in the particular case of public lands is considered. When resources are publicly owned, the price system is no longer used to allocate these resources. As a result, there is a lack of data on the market value of a product which makes decision making difficult. A popular approach to public investment decision making is to evaluate the difference (or ratios) between benefits and costs. However, the difficulty of assigning quantitative measures to benefits derived from non-market supplied goods and services has made the application of benefit-cost analysis difficult (an example being the pricing of water for recreation and domestic use). Recent research is devoted to placing a dollar valuation on non-market supplied resources. Such methods of valuation as consumer surplus, monopoly market value and cost have limited success when the values are used in resource allocation models. The author suggests a broader orientation to the multiple use problem. The market valuation system is not sufficient. First, resource management goals must be set and only then should valuation systems for benefit measurement be formulated. (Siegenthaler-Rutgers) W71-03624

#### PROCEEDINGS OF THE FOURTH AMERICAN WATER RESOURCES CONFERENCE. Geological Survey, Mineola, N.Y.

4th American Water Resources Conference, Commodore Hotel, New York, November 18-22, 1968, St. Anne, Illinois, Record Press, 1968. 793 p.

Descriptors: \*Water resource development, \*Water supply, \*Pollution, City planning, Mu-

nicipal water supply, Cities, Aquifers, Water management, Floods, Sewers, Storm runoff, Waste water, Water quality, Economic aspects, Regional analysis, Pollution, Droughts, Water resources research, River basins, Erosion, Meteorology. Identifiers: New York, Chicago, Wisconsin, Metropolitan area problems.

Papers were presented on the interdisciplinary interests of the participants in the fields of water-resources research, planning, development, management and education. Particular concentration was focused on metropolitan area water problems. The fifteen sessions were concerned with the water resource problems of the cities, storm runoff and waste water disposal, the economics of pollution and quality of the environment, regional water planning, super projects, flood control and flood plain management, citizen action and the problems of pollution and pollution control. Also discussed were the areas of groundwater in the urban environment, international water-resource programs, general water resources research, droughts and other meteorological considerations, urban water resources research, and national and local water policy. The problems were analyzed critically from several aspects with suggestion of possible solutions. (See also W71-03626 thru W71-03627) (Murphy-Rutgers) W71-03625

#### READINGS IN RESOURCE MANAGEMENT AND CONSERVATION. Toronto Univ., (Ontario); and Clark Univ., Worcester, Mass.

Edited by Sam Burton, and Robert W. Kates. Chicago, University of Chicago Press, 1965. 609 p.

Descriptors: \*Natural resources, \*Conservation, Population, Costs, Government, Economic evaluation, Geography, Land use, Technology, Farms, Resource allocation, Social aspects, Systems analysis, Agriculture, Water resource development, Decision-making, Economic analysis, Economic efficiency, Regional analysis.

Identifiers: Economic development.

This is a collection of papers which seek to explore some of the problems of resource management and conservation. The relationship between population and the resource limits of the earth is discussed followed by chapters describing the growth of the concept of conservation and the various social, economic and ethical factors involved. The following chapter contains a number of case studies dealing with problems involved in the area of natural resource management. Next to be examined is the relationship between natural resources and the economic growth of regions and countries. The effect upon resource management and conservation of scientific and technological change is then discussed. The concluding chapter contains a number of papers on various systems methods designed to evaluate the choice of relevant alternatives for natural resource development. Although concerned with all natural resources, the book contains numerous papers dealing specifically with water resources as well as papers whose conclusions are applicable to this area. (See also W71-03632 thru W71-03643) (Murphy-Rutgers) W71-03631

#### THE COLUMBIA BASIN PROJECT: EXPECTATIONS, REALIZATIONS, IMPLICATIONS, Delaware Univ., Newark.

George Macinko.

In: Readings In Resource Management and Conservation, Chicago, University of Chicago Press, 1965, p 289-297.

Descriptors: \*Water resource development, \*Columbia River Basin, \*Planning, \*Economic justification, River basins, Government, Irrigation, Land use, Dry farming, Costs, Technology, Budgets, Government supports, Demand. Identifiers: \*Columbia Basin Project, Time lag.

The author believes that the problems which have caused a halt in the development of the Columbia Basin Project are of a nature common to other water resource projects. He attempts to provide an overview of this Project in order to indicate what future developments can be expected in the field of reclamation. The author discusses the problems arising from the time lag between planning and implementation, overruning the project costs, increases in farm size and their relation to government subsidies, and changes in land use patterns. There is a need for greater flexibility in programming, closer attunement to the state of the national economy, reduction in lag time, and new economic analysis to justify reclamation development in the face of competing demands on the nation's water resources. (See also W71-03631) (Murphy-Rutgers) W71-03633

#### CONNECTIONS BETWEEN NATURAL RESOURCES AND ECONOMIC GROWTH, Chicago Univ., Ill.

Theodore W. Schultz.

In: Readings In Resource Management and Conservation, Chicago, University of Chicago Press, 1965, p 397-403.

Descriptors: \*Economic impact, \*Natural resources, Productivity, Capital, Labor, Rate of return, Economic evaluation, Supply, Prices, Land use, Costs, Technology, Equilibrium, Investment.

Identifiers: \*Economic growth, Primary production, Reproducible capital, Diminishing returns.

The author wishes to discover the connections between natural resources and economic growth and to dispense with the prevailing misconceptions in this area. The author's orientation is towards a theory concerning all natural resources and the economic growth of a country. However, the conclusions are readily applicable to water resources in particular and the specific water-related factors affecting regional economic growth. The paper examines the value of natural resources as a factor of production and dismisses as inadequate the view of that role originating from both the classical and Harroddian analysis. The author then investigates the contribution that natural resources can make to economic growth and finds that whether or not new forms of capital are adaptable to primary production is of vital importance in determining the role of natural resources. The article concludes by illuminating the connections between natural resources and reproducible non-human capital and the labor force. (See also W71-03631) (Murphy-Rutgers) W71-03635

#### A GUIDE TO BENEFIT-COST ANALYSIS, Chicago Univ., Ill.; British Columbia Univ., Vancouver; and Canada Advisory Committee on Water Use Policy, Ottawa (Ontario).

WRD Sewell, AD Scott, DW Ross, and John Davis.

In: Readings in Resources Management and Conservation, Chicago, University of Chicago Press,

1965, p 544-557.

Descriptors: \*Benefit-cost analysis, \*Economic evaluation, Investment, Rate of return, Economic justification, Project planning, Measurement, Joint costs, Decision-making, Optimization.

Identifiers: \*Externalities, Sunk costs, Intangible benefits.

Benefit-cost analysis is able to provide a logical framework for the evaluation of one or more courses of action in the area of water resource development. The authors attempt to provide a guide to the proper use of benefit cost analysis in this area. The different purposes for which benefit-cost analysis may be used are explained and exact definitions of the terms commonly employed are provided. The principles upon which benefit-cost analysis is based are given followed by an explanation of true economic cost. The results of benefit-cost analysis may differ according to the viewpoint of the evaluator. Accordingly, this viewpoint should be

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clearly stated. The optimum scale for a given development occurs at a point where its net benefits are at a maximum but economic comparisons among projects may be made by: comparisons of net benefits, comparisons of rates of return, or comparisons on the basis of benefit-cost ratios. These different methods are explained and in the final section the interdependence of projects is discussed. (See also W71-03631) (Murphy-Rutgers)  
W71-03636

#### MALTHUSIANISM AND CONSERVATION: THEIR ROLE AS ORIGINS OF THE DOCTRINE OF INCREASING ECONOMIC SCARCITY OF NATURAL RESOURCES,

Washington Univ., St. Louis, Mo.

Harold Barnett.

In: *Readings in Resource Management and Conservation*, Chicago, University of Chicago Press, 1965, p 204-226.

Descriptors: \*Natural resource development, \*Conservation, \*Economic efficiency, \*Pollution, Wastes, Streams, Costs, Dams, Balance of nature, Hydroelectric power, Technology, Population.

Identifiers: \*Malthus, Economic scarcity, Unearned increment, Diminishing returns, Economic growth.

This article deals with the economic scarcity of natural resources relative to population and goods consumption. The basic theories of Malthus on this problem are used to construct modern economic models of the relation between natural resources and economic growth. Both a static and a growth model result from the incorporation of strategic variables. Time horizons, rate of population increase, natural resources available, technology and institutions, and the law of diminishing returns are the five constraints included to insure Malthusian results. These Malthusian projections are then juxtaposed with the views of the contemporary conservationists. The former are most concerned with quality, rather than quantity, of available natural resources. In this capacity, interest has arisen in water pollution, soil conservation, and air pollution. The conservationists plead for the wise use of resources and the avoidance of waste for the purpose of promoting economic well-being. The problem of resource scarcity is particularly acute in the area of water resources, making this article of interest to the water researcher. (See also W71-03631) (Murphy-Rutgers)

W71-03637

#### POPULATION AND NATURAL RESOURCES,

Carnegie Institution of Washington, D.C.

For primary bibliographic entry see Field 06D.

W71-03638

#### WHAT IS CONSERVATION,

Resources for the Future, Inc. Washington, D.C.

Orris C. Herfindahl.

In: *Readings in Resource Management and Conservation*, Chicago, University of Chicago Press, 1965, p 229-236.

Descriptors: \*Conservation, \*Natural resource development, \*Water use, Dams, Lakes, Minerals, Forests, Irrigation, Water supply, Costs, Benefits, Streams, Fishing, Recreation, Industrial water use. Identifiers: \*Pinchot, Wildlife refuge, Private market system, Import limitation.

This article deals with the imprecision surrounding use of the word conservation. The author first treats Pinchot's definition of conservation as the use of natural resources for the greatest good of the greatest number for the longest time. Also handled is Pinchot's premise that conservation implies both the development and protection of natural resources. The author challenges the possible co-existence of these two objectives, citing as an example, the construction of a dam which necessarily interferes with the preservation of the environ-

ment's natural beauty. Conflict between varying interest groups is blamed for the preservation of Pinchot's lack of clarity in the writings of contemporary conservationists. The dam type of controversy is not the only conflict. Various types of development are also opposed to each other, such as irrigation and urban water supply. To solve these definitional problems, conservation can be regarded as a means of maximizing the return from all resources at the disposal of society. It is pointed out that in all such conservation measures, the benefits must outweigh the costs to ensure economic feasibility. Since water resources conservation is an important part of the total conservation effort, this article should be of interest to the water researcher. (See also W71-03631) (Murphy-Rutgers)

W71-03639

government cost of borrowing. The jurisdictional jealousies of the several construction agencies act as a force preventing the consideration of relevant alternatives which may result in a higher benefit cost ratio. The author also discusses various institutional arrangements which make rational decision all but impossible in the water development field. Included here is: the absence of countervailing powers, the disadvantages arising from our representative form of government, and individual loyalty to the agency organization. In the final section the author deals with the professionalization of economists in government service and shifts in the location of the decision making authority in the national government as possible solutions to the problem. (See also W71-03631) (Murphy-Rutgers)

W71-03642

#### WORLD RESOURCES AND TECHNOLOGY,

London Univ. (England).

For primary bibliographic entry see Field 06E.

W71-03640

#### WELFARE, ECONOMICS AND RESOURCE DEVELOPMENT,

Indiana Univ., Bloomington.

J. W. Millman.

In: *Readings in Resource Management and Conservation*, Chicago, University of Chicago Press, p 284-288, 1965.

Descriptors: \*Water supply, \*Economic evaluation, \*Economic efficiency, Water demand, Prices, Elasticity of demand, Water law, Investment, Water resource development, Government, Cost-benefit analysis, Water rights, Rate of discount.

Identifiers: \*Water subsidies, \*Project analysis.

Conclusions and highlights are presented of a water supply study recently completed. The study was divided into the examination of the allocation of existing water supplies and a study of the alternatives for developing new supplies. They found that water supplies were grossly misallocated among and between uses and it is these misallocations which lead to claims of water shortage. The authors also believe that major water investments in the United States are typically undertaken prematurely and on an over ambitious scale. Some of the reasons for the resulting over investment in water supply are given as the failure to adjust prices for the purpose of changing demand and the biases inherent in conventional techniques of project analysis. In conclusion, the author states that increased application of economic principles will produce greater efficiency in water supply in relation to all the other desires of the community. (See also W71-03631) (Murphy-Rutgers)

W71-03641

#### NATURAL RESOURCE ENDOWMENT AND REGIONAL ECONOMIC GROWTH,

Resources for the Future, Inc., Washington, D.C.

Harvey S. Perloff, and Lowdon Wingo.

In: *Readings in Resource Management and Conservation*, Chicago, University of Chicago Press, p 427-442, 1965.

Descriptors: \*Natural resources, \*Regional analysis, Technology, Economic analysis, Industrial production, Agriculture, Income, Demand, Population.

Identifiers: \*Resource endowment, \*Economic growth, Heartland-hinterland, \*Cumulative advantage.

An adequate water supply is a vital parameter in determining the economic future of an area. This paper is concerned with the relationship between the natural resources (including the water resources) of a region and the nature of economic expansion. The authors find that resource endowment is continuously redefined by changes in final and intermediate demand, production technology and economic organization. The relative economic growth of a region is directly related to its relative advantages in the production of goods and services for the national market. The working out of cumulative advantage is exhibited in the specialized role which a region plays in the national economy, and this specialized role can best be described in terms of the heartland-hinterland relationships. (See also W71-03631) (Murphy-Rutgers)

W71-03643

#### TECHNIQUES OF PROJECT APPRAISAL,

Chicago Univ., Ill.

Arnold Harberger.

In: *National Economic Planning*, New York, Columbia University Press, p 131-149, 1967.

Descriptors: \*Decision-making, Risk, Cost-benefit analysis, Marginal productivity, Discount rate, Demand function.

Identifiers: \*Project appraisal, \*Shadow prices, Time path, Capital market, New benefit, Externalities, Opportunity cost.

The effect of uncertainty on project appraisals is considered. In particular, the focus is primarily on the implications of changes in the discount rate for decision-making and cost-benefit analysis. The author rejects the argument that private investors excessively discount the future on grounds of risk. He recommends the observed past average social rate of return to capital as the best approximation of the discount rate for cost-benefit analysis. This advice is based on the assumption that relevant long term future rate of discount can be assumed constant and near the historical average, a finding useful for decision-makers. When market prices do not reflect the scarcity value of inputs, shadow prices are used. The use of a shadow price below the market price results in a much higher shadow rate of return to capital than the market rate and hence excessively high discount rates for future projects. The author cautions against the use of low or near zero shadow prices to avoid this problem.

This article provides a comprehensive discussion of discount rate issues in public investment projects and should prove valuable to water investment studies. (Siegenthaler-Rutgers)  
W71-03646

**THE PLANNING PROGRAMMING-BUDGETING APPROACH TO GOVERNMENT DECISION-MAKING,**  
Battelle Memorial Inst., Columbus, Ohio.  
Harold A. Hovey.  
New York, Frederick A. Praeger, 1968. 264 p.

Descriptors: \*Decision-making, \*Cost-benefit analysis, Program budgeting, Resource allocation, Economic efficiency, Constraint, Marginal cost, Interest rate.

Identifiers: \*Planning-Programming-Budgeting, \*System cost, Opportunity cost, Cost-effectiveness, Externalities, Subsidies, Income redistribution, Consumer surplus, User charge, Shadow pricing.

This book presents the basic elements of the Planning-Programming-Budgeting (PPB) approach to decision-making. Under the PPB approach, both the budget and the program can be organized on the basis of program categories reflecting valued outputs of government programs permitting decision-makers to consider all costs in relation to the purpose pursued by government. The author discusses the identification of program goals, cost measurement, cost-effectiveness and cost-benefit analysis. Examples were presented to show that PPB can expose important issues and thereby improve information available to the political decision-maker. The problems connected with PPB of both a conceptual and operational nature were discussed. The author concludes that if PPB is supported and implemented by Congress and Administrators, it will be possible to effect major improvements in government planning and budgeting. The book is relevant for water resource planners concerned with program budgeting and the economic evaluation of both existing and planned projects. (Siegenthaler-Rutgers)  
W71-03648

**ECONOMIC ANALYSIS OF PUBLIC INVESTMENT DECISIONS: INTEREST RATE POLICY AND DISCOUNTING ANALYSIS.**

Joint Committee on Economics (U.S. Congress).

Hearings before the Subcommittee on Economy in Government of the Joint Economic Committee, Ninetieth Congress, July 30, 31, and August 1, 1968. Washington, U. S. Government Printing Office, 1968. 193 p.

Descriptors: \*Discount rate, \*Interest rate, \*Decision making, Cost-benefit analysis, Economic efficiency, Risk, Uncertainty, Economic evaluation, Inflation, Resource allocation.

Identifiers: \*Public investment, \*Social rate of interest, Capital rationing, Capital market, Two-part pricing, Opportunity cost.

The objective of these hearings was to consider the economic evaluation of public investment and to establish a conceptual framework for Government interest rate policy. On the basis of this concept, the committee desired to establish an accurate measure of the interest rate to be used for government projects. Witnesses from Government agencies and academia provided testimony on this subject. Government discounting practices were determined to be neither consistent nor appropriate. Given imperfect capital markets, a range of concepts were offered as the appropriate public discount rate including the social rate of time preference, the cost to the Treasury of borrowing, the opportunity cost of displaced spending measured by the opportunity cost of return on investment or tax-financed investment. The sub-committee recommended that no public investment be deemed efficient or economic if it fails to yield overall benefits as large as the same resources in the private sector. The Committee, furthermore,

stressed the need for research on the opportunity cost of private spending displaced by Government investment. The cost of the noneconomic impact of public spending must be recognized as well in order that accurate evaluation of the real national economic impact can be made. This study is important for water planners concerned with the economic evaluation process of investment decisions. (See also W71-03650 thru W71-03651) (Siegenthaler-Rutgers)  
W71-03649

**INTEREST RATE POLICY FOR THE EVALUATION OF FEDERAL PROGRAMS,**  
Harvard Univ., Cambridge, Mass.  
Otto Eckstein.

In: *Economic Analysis of Public Investment Decisions: Interest Rate Policy and Discounting Analysis*, Hearings of the Joint Economic Committee, July 30, 31, and August 1, 1968, Washington, Government Printing Office, p 50-56, 1968.

Descriptors: \*Interest rate, \*Economic efficiency, Economic evaluation, Investment decision, Risk, Cost-benefit analysis.

Identifiers: \*Capital market, \*Rate of return, Capital intensity, Liquidity, Social rate of time preference.

Interest rate policy for decision-making in the public sector is discussed. Interest rates which are below optimal levels result in excessive capital intensity and scale of development. With imperfect capital markets, the author considers the social rate of time preference and the opportunity cost of public capital as means of solving the interest rate problem in the public sector. A theoretical solution to the problem is given by first applying the social time preference rate of interest on project valuation, and then computing the cost-benefit ratio of foregone opportunities in the public and private sector. Projects are undertaken that have a cost-benefit ratio greater than the ratio of foregone opportunities. This method is difficult to apply since there is no accepted empirical definition of social time preference. The author feels a correct method is to use an opportunity cost estimate based on tax financing which results in a higher interest rate than a borrowing concept and is more realistic vis-a-vis the capital market. This article is important for water studies involved with the efficient utilization of government water investment expenditures. (See also W71-03649) (Siegenthaler-Rutgers)  
W71-03650

**CONTRAST BETWEEN WELFARE CONDITIONS FOR JOINT SUPPLY AND FOR PUBLIC GOODS,**

Massachusetts Inst. of Tech., Cambridge.

Paul A. Samuelson.

Review of Economics and Statistics Vol 51, No 1, p 26-30, February 1969.

Descriptors: \*Welfare economics, \*Social aspects, Economic efficiency, Government, Optimization, Decision making, Marginal cost, Demand, Mathematical study, Costs, Economic evaluation.

Identifiers: \*Public goods, Marginal utility, Production functions.

The author feels that for joint products, as the number of persons on both sides of the market increases, there is convergence in the usual fashion to the conditions of perfect competition. However, when the number of persons is increased in the case of a typical public good the problem becomes more indeterminate. The author attempts to provide a statement in terms of modern welfare economics of the various optimality conditions as they appear in the case of joint products. Certain aspects of water resources are commonly classified as a public good and analyzed as a good in joint supply. The paper shows that if the production functions satisfy the strict returns conditions conducive to perfect competition, the market place will determine the optimal resource allocation. Thus, the author concludes, there are real demand functions involved in

standard joint products. The conclusion represents an intrinsic contrast to the public good case. The general theoretical public good arguments of this paper together with the use of flood control examples makes this article relevant to the water research area. (Murphy-Rutgers)  
W71-03652

**NATIONAL ECONOMIC PLANNING,**  
Massachusetts Inst. of Tech., Cambridge.

Max F. Millikan.  
New York, Columbia University Press, 1967. 413 p.

Descriptors: \*Economic planning, Resource allocation, Economic evaluation, Optimization, Input-output-analysis.

Identifiers: \*Public expenditure, \*Public good, Locational choice, Project appraisal, Objective function, Externalities, Sensitivity analysis.

This book is the result of a conference held on national economic planning. The focus is the analytic tools being utilized by economists in the planning process in countries at different stages of growth and degrees of centralization in decision-making. The first set of papers deal with functional problems common to planning. The second set of papers deals with the technique of planning in different countries. The functional issues considered were locational choice, techniques of project appraisal, and the planning of public expenditure. The question of whether planning models are useful to decision-makers was considered. The problems of restrictive assumptions, inadequacy of data, and multiplicity of goals were stressed. This book is relevant for water resource planners concerned with the economic evaluation of particular projects and the relationship to the overall government planning role. (Siegenthaler-Rutgers)  
W71-03653

**THE INTEGRATION OF EQUITY AND EFFICIENCY CRITERIA IN PUBLIC PROJECT SELECTION,**

Maryland Univ., College Park; and Urban Inst., Washington, D.C.

Martin C. McGuire, and Harvey A. Garn.  
Economic Journal, Vol 79, No 316, p 882-893, December 1969.

Descriptors: \*Economic efficiency, Cost-benefit ratio, Public project planning, Regional development, Budget constraint.

Identifiers: \*Equity, Economic welfare, Welfare index, Payoff, Objective function, Marginal utility of money welfare function.

The formulation and implementation of equity and efficiency criteria in the selection of regional development projects in the United States is discussed. The authors construct and apply Bergsonian-type welfare functions in an operational context. A welfare index based on low family income, high unemployment rates and economic distress is constructed for use of the Economic Development Administration in project selection. This leads to a decision rule to evaluate all projects by weighting benefit-cost ratios by a welfare index. Following Eckstein, projects can be selected by maximizing the sum of the scores on the index subject to budget constraints. This method assists a program administrator by providing an operational project selection system flexible enough to allow for variation in project quality and for the tradeoff between efficiency and equity. This paper is relevant for water studies involved in the investment decision making process and project evaluation. (Siegenthaler-Rutgers)  
W71-03655

**INFORMED JUDGMENT, RIGOROUS THEORY AND PUBLIC POLICY,**

Princeton Univ., N.J.  
William J. Baumol.  
Southern Economic Journal, Vol 32, No 2, p 137-145, October 1965.

## Field 06—WATER RESOURCES PLANNING

### Group 6B—Evaluation Process

Descriptors: \*Welfare economics, \*Decision-making, Probability, Economic growth, Costs, Marginal cost pricing.

Identifiers: Second-best theorem, Externalities, Optimality, Social welfare function, Subsidy, Pareto criteria, Net benefit.

The impact of the second-best theorem and externality theory on policy making is considered. The second-best theorem states that in a situation characterized by a deviation from perfect optimality, partial policy measures attempting to eliminate some of the deviation may result in a new decrease in social welfare. The impact of the theorem for public policy-making is considerable. For example, corrective policies attempting the application of marginal cost pricing might lead to reduction in social welfare. With respect to externalities, theory states activities resulting in external benefits will, without regulation, fall below the ideal level. Accordingly, public policy must expand these activities by subsidy but limit activities characterized by external costs. Recently, extensions of this theory indicate that a social welfare function with multiple maxima may exist as a result of externalities. This article indicates that it is still possible to achieve improvements in social welfare through the original externality theory. This article provides a general theoretical background to water research efforts involving issues of externalities and pricing policies. (Siegenthaler-Rutgers)

W71-03656

#### THE STATUS OF PPB IN FEDERAL AGENCIES: A COMPARATIVE PERSPECTIVE,

General Accounting Office, Washington, D.C.; and

Bureau of the Budget, Washington, D.C.

Keith E. Marvin, and Andrew M. Rouse.

In: The Analysis and Evaluation of Public Expenditures: the PPB System, a compendium of papers submitted to the Subcommittee on Economy in Government of the Joint Economic Committee, U.S. Government Printing Office, Washington, D.C., Vol 3, p 801-814, 1969.

Descriptors: \*Planning, \*Budgeting, \*Programing, \*Economic evaluation, Forecasting, Systems analysis, Decisionmaking, Management, Government, Training.

Identifiers: \*PPB, Federal agencies, Congressional attitude, Personnel qualification, Organizational pattern, PPB analysis.

This paper describes the current status of Planning, Programing and Budgeting, (PPB), in the Federal agencies and the facts which appear to account for the different degrees of effectiveness in its application. The article is based on recent surveys of PPB systems which looked at the way in which they had been developed from the point of view of agency management. The paper is of particular interest to the water researcher, not only for its description of the PPB process, but also for its isolation of those conditions which are most conducive to the development of an effective PPB system. The authors first describe what the original expectations for the PPB system were and what was actually created. Thirteen factors which appear in each agency that has made substantial progress toward the development of PPB systems for policy decisionmaking are isolated. (See also W70-08721) (Murphy-Rutgers)

W71-03657

#### RESCUING POLICY ANALYSIS FROM PPBS,

California Univ., Berkeley.

Aaron Wildavsky.

In: The Analysis and Evaluation of Public Expenditures: the PPB System, a Compendium of papers submitted to the Subcommittee on Economy in Government of the Joint Economic Committee, U.S. Government Printing Office, Washington, D.C., Vol III, p 835-864, 1969.

Descriptors: \*Systems analysis, \*Economic evaluation, \*Budgeting, \*Government, Planning, Decision-making, Training, Model studies, Risks, Programs, Federal budgets, Economic justification, Management, Demand, Supply.

Identifiers: \*PPB system, Inertia defense analysis.

The author feels that, despite the increasing necessity for policy analysis in the governmental area, the Planning-Programming-Budgeting (PPB) system is completely inappropriate to current needs. Since this has often been used in evaluating public water resource investments, the author's ideas have relevance for the water resource planner. The paper discusses the flaws in the PPB system which have caused it to fall short of expectations. PPB was a success in defense analysis because extreme cases were allowed to determine the outcome. This cannot be done in non-defense projects and it is more difficult to apply in these areas. The author feels that the emphasis on program structure, and the formal connection of policy analysis with the budget cycle, sacrifice sound analysis, initiative and imagination for pro forma structure and schedule. (See also W70-08721) (Murphy-Rutgers)

W71-03658

#### THE ROLE OF COST UTILITY ANALYSIS IN PROGRAM BUDGETING,

Rand Corp., Santa Monica, Calif.

Gene H. Fisher.

In: Public Budgeting and Finance, Itasca, Illinois, Peacock Publishers, p 545-560, 1968.

Descriptors: \*Cost-benefit analysis, \*Decision-making, Planning, Economic evaluation, Risks, Management, Utility, Time, Budgeting, Resource allocation, Economic feasibility, Optimization, Systems analysis.

Identifiers: \*Cost utility analysis, Rand Corporation, Program-budgeting.

This paper provides a discussion of considerations of the analytical process in program budgeting. The objective of this type of analytical effort is to systematically examine alternative courses of action in terms of utility and cost with the purpose of clarifying the relevant choices open to the decision maker. Thus, after a brief discussion of some analytical methods and techniques used in the program budgeting process, the author explains the use of cost utility analysis, pointing out six main characteristics and presenting an example of its use. The article demonstrates that where major uncertainties are present in decisions pertaining to the initiation of development for a total system, the analysis may suggest relatively inexpensive component development programs which minimize the risk. The analysis used in this study is closely related to cost benefit analysis and an understanding of this article could be of assistance in the evaluation of water resource investments. (Murphy-Rutgers)

W71-03659

#### CALIFORNIA'S PROGRAMING AND BUDGETING SYSTEM,

California State Dept. of Finance, Sacramento.

Edwin W. Beach.

In: Innovations In Planning, Programing, and Budgeting In State and Local Governments, a compendium of papers submitted to the Subcommittee on Economy In Government of the Joint Economic Committee, U.S. Government Printing Office, Washington, D.C., p 27-35, 1969.

Descriptors: \*Planning, \*Budgets, \*Forecasting, \*Management, Government, Financing, Costs, Benefits, Economic evaluation, Decisionmaking, Systems analysis, Data collection, \*California.

Identifiers: \*Programing, \*PPB, Multi-year programs, Agency planning.

The necessity for choosing among many alternatives forced the development of the Programing and Budgeting System. The main value of the Programing and Budgeting System is that it provides an increased capability to consider the costs and benefits of various program alternatives. This is a problem consistently faced in the water resource area so that this article, which provides a review of the structure of California's Programing and Budgeting System and the progress to date in im-

plementing it, should be of interest to the water researcher. In addition, the author explains the relationship of the Programing and Budgeting System to the function of planning and states that it is one of the most significant improvements to the management process in a long time. (Murphy-Rutgers)

W71-03660

#### DEVELOPMENT OF PPB SYSTEM IN THE STATE OF MICHIGAN,

Michigan State Budget Director.

Paul A. Wileden.

In: Innovation In Planning Programing And Budgeting in State And Local Governments, a compendium of papers submitted to the Subcommittee On Economy In Government of the Joint Economic Committee, U. S. Government Printing Office, Washington, D.C., p 36-47 1969.

Descriptors: \*Planning, \*Budgeting, \*Economic evaluation, Forecasting, Systems analysis, Training, Benefits, Costs, Resource development, Financing, Social aspects, Economic analysis, Government.

Identifiers: \*Michigan, \*Programing, \*PPB, Multiyear framework, Program identification.

The author explains the need to replace the earlier types of input-orientated budget decisions with those more relevant to purpose, performance and related cost factors. The article describes the planning, programming and budgeting (PPB) process as being ideally suited for this purpose. The structure and components of the PPB system in the state of Michigan, are described in relation to the objective of producing an out-put orientated program budget within a multiyear framework, based on adequate systematic analysis of alternatives, and reflecting pertinent costs in relation to results. The current stage of PPB development is discussed and the need stressed for greater personnel training. The decisions that the state is forced to make are similar to those in the public water resources area. The article appraises the PPB system as enabling a more rational determination of the relevant priorities in allocating scarce public resources, through systematic analysis and evaluation of program productivity in response to social needs. Thus, the use of this system may enable a better use of scarce public water resources. (Murphy-Rutgers)

W71-03661

#### PPBS IN CITY, STATE AND COUNTY: AN OVERVIEW,

Selma J. Mushkin.

In: Innovations In Planning, Programing, and Budgeting In State and Local Governments, a compendium of papers submitted to the Subcommittee on Economy In Government of the Joint Economic Committee, U.S. Government Printing Office, Washington, D.C., p 1-14 1969.

Descriptors: \*Economic evaluation, \*Planning, Budgeting, \*Decision-making, \*Government, Costs, Benefits, Forecasting, Optimization, Training, Model studies, Economic efficiency, Resource allocation.

Identifiers: \*PPB, \*Programing, 5-5 project.

In this paper the author describes the applications of planning, programing and budgeting (PPB) systems in the state and local governments as well as the results of the application of these systems. The PPB system has proven to be a method of economic evaluation particularly suited to the water resource area. Thus, this article should prove of interest to those concerned with public water resource investments. The author describes two approaches to PPB systems application which she labels as the incremental approach and the systematic approach. They are evaluated in terms of their effectiveness in forcing more rational public decisions on the allocation of scarce resources and improved comparison of the cost and effectiveness of program options. The results of a number of projects are analyzed, with emphasis on the problems involved and the lessons learned. The author

presents those changes she thinks are necessary for a more effective use of PPB systems. The paper concludes with a list of the outputs of present applications of PPB. (Murphy-Rutgers)  
W71-03662

#### THE NEW YORK STATE PLANNING, PROGRAMMING AND BUDGETING SYSTEM, David A. Seyler.

In: Innovations In Planning Programming and Budgeting In State And Local Governments, a compendium of papers submitted to the Subcommittee On Economy In Government of the Joint Economic Committee, U.S. Government Printing Office, Washington, D.C., p 48-52 1969.

Descriptors: \*Planning, \*Budgeting, \*Economic evaluation, \*Decisionmaking, Costs, Benefits, Forecasting, Training, Optimization, Resource allocation, Economic efficiency, Government, Systems analysis.

Identifiers: \*New York, Programming, Program structure.

Since 1964, New York State has been developing a Planning, Programming and Budgeting System, (PPBS), which systematically relates the expenditure of funds to the accomplishment of planned goals. One of the initial steps was the development of a Program Structure in order to provide a framework for resource allocation decisionmaking. Major emphasis is also placed on the scheduling and execution of program analysis throughout state government. The PPBS system has changed the budgetary process so that there has been a conversion from a budget presented in object terms to a program budget. There are several problems remaining in utilizing PPBS effectively with major emphasis needed on the development of meaningful output information. The PPBS method of evaluating alternatives is particularly useful in the water resources area and New York State's experience in its application should prove to be of interest to the water researcher. (Murphy-Rutgers)  
W71-03663

#### USER RESPONSE IN OUTDOOR RECREATION: A COMMENT, Cornell Univ., Ithaca, N. Y.

Lois E. Gosse, and Robert E. Kalter.  
Journal of Leisure Research, Vol 2, No 2, p 131-134, Spring 1970.

Descriptors: \*Recreation, \*Resource allocation, Demand, Supply, Investment, Forecasting.  
Identifiers: \*User response, Production function, Capacity, Travel costs, Consumer surplus, Identification problem, Marginal rate of substitution.

The author considers the article: 'User Response in Outdoor Recreation: A Production Analysis' (JLR: Summer 1969) by Seneca and Cicchetti. The production function for recreational sites introduced in the article is based on recreational use and not site capacity. Kalter and Gosse question the assumption that the total recreation consumed is identical to the total output or capacity of the park. With the recreation market implied, the supply of recreational facilities is so restricted that any given increase in supply would still result in a proportional increase in use or excess demand would exist. However, the user response equation does not consider the possibility that the location of new facilities can influence the amount of new recreational use. For policy making, a measure of the value of the potential recreational site to society is necessary in addition to the relation between recreation use and supply yielded by the user response model. The value measure can be found by approximating the consumer surplus for the associated demand function. However, the user response model is an important aid for recreation planners. (Siegenthaler-Rutgers)  
W71-03664

#### AN ECONOMIC EVALUATION OF CONNECTICUT WATER LAW: WATER RIGHTS, PUBLIC WATER SUPPLY AND POLLUTION CONTROL, Connecticut Univ., Storrs. Inst. of Water Resources.

Robert L. Leonard.

Available from NTIS as PB-196 898, \$3.00 in paper copy, \$0.95 in microfiche. Institute of Water Resources, Univ of Connecticut, Report No 11, July 1970. 67 p, 5 tab, 136 ref, 2 append. OWRR Project A-012-CONN (5).

Descriptors: \*Connecticut, \*Economic efficiency, \*Water law, \*Economic feasibility, Economics, Legal aspects, Water resources, Economic impact, Economic justification, Pollution abatement, Water quality control, Riparian rights, Cost-benefit analysis, Water supply, Streamflow, Regulated flow, Consumptive uses, Groundwater, Condemnation, Compensation, Administrative decisions, Recreation demand, Public rights, Grants, Legislation.

Utilizing economic criteria, this report analyzes Connecticut's water law system. The author employs as evaluatory tools cost-benefit analysis and the degree of economic flexibility afforded by water rights and regulations. Competing property rights, economic models, public policies and programs, and research incentives are interrelated with economic costs. Recommendations are made in four areas: (1) public water supplies, (2) water rights, (3) stream flow and groundwater management, and (4) pollution control. The effect of the non-riparian status of Connecticut's public water supplies is considered in light of condemnation powers, compensation requirements, and legislative restrictions. Locational advantages, common-law pollution protection, efficiency in allocating among consumptive uses, and the ineffectiveness of riparian doctrines in protecting recreational and environmental values are all discussed as they relate to suggested improvements in Connecticut's existing water law system. Stream flow and groundwater management are examined in terms of the authority needed for governmental management, stream flow objectives, administrative problems, and the impact on water users. The lack of economic incentives for pollution abatement, water-quality criteria, financial assistance, and the exercise of regulatory powers are considered in analyzing pollution and water quality control. (Earl-Florida)  
W71-03732

#### A REGIONAL WATER RESOURCE MANAGEMENT PLAN FOR DANE COUNTY.

Bauer, Sheaffer, and McCall, Inc., Chicago, Ill.

Dane County, Michigan, Regional Planning Commission, 1970. 166 p, 23 fig, 13 tab, 2 append.

Descriptors: \*Plan, \*Regional analysis, \*Water resources, \*Sprinkler irrigation, \*Waste water treatment, \*Waste management, Flow, Diversion, Groundwater basins, Water pollution, Eutrophication, Evaluation, Drainage.

Identifiers: \*Goals, Agriculture drainage, Urban drainage, Madison metropolitan area, Stoughton area, Upper Yahara river basin.

The report attempts to develop a conceptual plan for the total management of water resources, including both surface and groundwater. The key elements of the plan are two spray irrigation-waste water treatment facilities, one for the Madison Metropolitan Area and one for the Stoughton Area. The former would serve to discontinue the diversion of effluent and would return it to the Upper Yahara Basin where more water flow, because of diversion, is needed. The plan includes a water supply element where repositioning of groundwater wells near groundwater basin perimeters would reduce potential groundwater contamination and increase the size of the groundwater basin. Also, a drainage element considers both urban drainage and rural-agricultural

drainage and the possible management opportunities. (Miller-Chicago)  
W71-03760

#### A PROGRESS REPORT ON THE FUTURE OF CHICAGO'S LAKEFRONT.

Johnson, Johnson and Roy, Inc., Ann Arbor, Mich.

Preliminary Report, February 1968. 52 p.

Descriptors: \*Lake Michigan, \*City planning, \*Planning, \*Resource development, \*Parks, \*Land use, Lake shores, Lakes, Aesthetics, Recreation, Recreation facilities, Management.

Identifiers: \*Chicago, \*Lakefront development.

A number of basic study objectives which characterize the report can be identified: (a) to reconfirm the manner in which the lakeshore has served the people of Chicago in the past; (b) to discover how the lakeshore is most effectively used today; (c) to discover the best possible use of the lakeshore as a recreation resource; (d) to chart the potentials for increased recreation land areas along the shore or off shore; (e) to match future potentials for use with appropriate access patterns; (f) to recommend basic action programs which would lead towards the full measure of future potential inherent in the lakeshore; and (g) to establish basic principles of shoreline development which can be directly beneficial to numerous and otherwise unrelated public and private developments along the shore. (Davis-Chicago)  
W71-03761

#### ECONOMICS AND ECOLOGY,

Michigan Univ., Ann Arbor. Dept. of Economics.

Kenneth E. Boulding.

In: Future Environments of North America, ed. Darling, F. Fraser and Milton, John P. (The Natural Press: Garden City, New York, 1966) p 225-234. 1 ref.

Descriptors: \*Economics, \*Ecology, Equilibrium, Ethics.

Identifiers: Policy, Individuals, Species, Exchange systems, Closed systems, Resources.

While there has been little interaction between the sciences of economics and ecology, there are striking parallels between the two. Five basic similarities are outlined. First, both study not only individuals as such but individuals as members of species. Second, both have an important concept of general equilibrium, one dealing with population, the other with the price system. Third, both involve a system of exchange among their various individuals and species as an essential element in determining their final equilibrium, in one symbolized by the price system, in the other by the metabolic system. Fourth, both imply some concept of development. And fifth, important parallels fall under the general head of policy, i.e., the distortion of the system equilibrium in favor of man. The fact that we distort the ecosystem in favor of man does not mean that we destroy the principles of general equilibrium of populations. The author contends that the failure of most social policies is a result of man not cooperating with the ecological forces determining population equilibrium. In spite of the similarities there are important differences. Economists are irretrievably man-centered; no ecological concept corresponds to the economists' gross national product. The ecologists' value system encompasses all species, and this difference involves deep ethical problems, among them species' extinction. However, man's speeding up of the evolutionary process puts up Dead End signs for the ecologist and Thin Ice signs for the economist. Finally, the author discusses the implications that result from looking at resources as infinite and looking at them in terms of a closed system. (Preckwinkle-Chicago)  
W71-03762

## Field 06—WATER RESOURCES PLANNING

### Group 6B—Evaluation Process

**STANDARDS AND TECHNIQUES OF EVALUATING ECONOMIC CHOICES IN ENVIRONMENTAL RESOURCE DEVELOPMENT,** Michigan Univ., Ann Arbor. School of Natural Resources.

Ayers Brinser.

In: Future Environments of North America, ed. Darling, F. Fraser and Milton, John P. (The Natural History Press: Garden City, New York, 1966), p 235-245. 27 ref.

Descriptors: \*Economics, \*Methodology, Investment, Conservation.

Identifiers: \*Economic choice, \*Environmental resource development, \*Environmental quality, Comprehensive planning, Incremental planning, Criteria.

The author begins by defining terms. Economic choice is an attempt to state 'who should pay how much for what' and environmental resource development is equivalent to economic welfare with a major objective the enhancement of the quality of living. However, it is not clear that economics as defined by many practicing economists is a proper instrument for evaluating decisions about investment in environmental development. At present, it is argued, we are still in a period of trying to create methodologies. Concepts on which those methods are based are not resolving issues. The problem of evaluating economic choices remains in general terms to find measurements that will show how much more or how much less. It is unlikely that with present techniques such criteria could be embodied in a comprehensive plan. We lack the necessary tools for discovering either individual and social time preferences or for finding their proper relationship. The same problem of relationship holds for private and public funds invested in improving the quality of the environment. Comprehensive design with incremental planning may provide for more effective development. The criteria selected for alternative investment opportunities should be designed to promote growth and development. Rather than aiming at preserving what is or restoring the past, they should be concerned with improving the quality of choices that will come in the future. Again, incremental planning appears necessary. The major purpose of criteria must include increasing opportunities for external economics flowing from public as well as private investment with the choice of criteria not confined by an overwhelming concern for scarcity. (Pleckwinkle-Chicago)

W71-03763

**EVALUATION OF RECREATION AND AESTHETIC USES OF WATER IN AN URBAN SETTING,** Chicago Univ., Ill.

Orville F. Grimes.

Paper, Urban Economics Workshop, University of Chicago, 27 February 1970. 28 p, 6 fig, 2 tab, 16 ref.

Descriptors: \*Evaluation, \*Aesthetics, \*Cities, \*Recreation, \*Economic impact, Planning, Urbanization, Water resources, Recreation demand, Recreation facilities, Benefits, Value, Shores.

Identifiers: \*Urban areas, \*Recreational uses, \*Aesthetic uses, Value of views, Urban environment.

The structure of the demand for water-oriented outdoor recreation activities is examined. Also explored are the ways in which this demand is effected by concentrations of people in urban areas, characteristics of urban people, and the urban environment. Various categories of urban recreation benefits are specified: (a) public recreational use of shoreline inside or outside the city; (b) value of views of the water area to residents along the shoreline; (c) value of views of the water area to non-residents; and (d) private recreational use of shoreline inside or outside the city by city residents. Hypotheses regarding the relative importance of these benefits are examined. A category of benefits is selected for empirical analysis and some preliminary analysis, and some preliminary findings are presented. (Davis-Chicago)

W71-03765

**WATER RESOURCES AND LAND USE OF THE PYRAMID LAKE INDIAN RESERVATION.** Wilsey and Ham, San Mateo, Calif.

Available from NTIS as PB-195 088, \$3.00 in paper copy, \$0.95 in microfiche. Final report to Economic Development Administration, EDACCOMM-70-012, Oct 1970. 187 p, 13 tab, 15 fig, 44 ref.

Identifiers: \*Water resources, \*Nevada, \*Economic development, Lakes, Employment, Land use, Stabilization, Irrigation, Electric power generation, Pyramid Lake, Pyramid Paiute Indian Reservation, Tourism, \*Indian reservations, Technical assistance projects.

Data are presented and recommendations made for establishment of a permanent employment and income base for the Pyramid Paiute Indian Reservation in Nevada. Findings indicate public and private investment in the area have been inhibited because of uncertainty potable water supply, general land use planning, and the shrinking of the lake through diversion of the Truckee River. Restoration of river flows to stabilize the lake, and protection and enhancement of the lake to develop tourism are described as political and legal considerations. Economic value of water used to supplement flows in Pyramid Lake is discussed in terms of irrigation and operation of a power plant. Need for a general land use plan is described in terms of agriculture, town needs, conservation, and recreation and tourism.

W71-03769

**SUMMARY OF EVALUATION PROCESSES IN WATER RESOURCES PLANNING,** Rutgers - The State Univ., New Brunswick, N.J. Water Resources Research Inst.

William Whipple, Jr.

Water Resources Bulletin, Vol 6, No 4, AWRA News, An AWRA Research Conference, Univ of Wisconsin - Milwaukee, June 14-19, 1970, p 700-703, July-Aug 1970. 4 p.

Descriptors: \*Evaluation, \*Planning, \*Water resources, \*Conferences, Optimization, Computers, Water quality control, Flood plains, Interest rate, Discount rate, Regional analysis.

Identifiers: Multiple objective functions.

A summary of the AWRA Conference, 'Evaluation Processes in Water Resources Planning', was given. Certain developments of general interest were summarized. First, the Conference reached a consensus that computer-based systems analysis is an essential part of the planning process which has not yet been fully utilized, and which has further capabilities particularly in the outlining of alternatives. However, opinions were expressed that, emphasis must be shifted to improve data and inputs, rather than approaches. It was thought that there is a need for expanded research in the nation-wide system of standards for water quality control established by the Federal Government. There was a discussion of benefits of environmental quality where it is extremely difficult to evaluate environmental objectives. Three alternative approaches to a system of planning based upon multiple objective functions were suggested at the Conference. It was explored in connection with the subject of metropolitan area planning. A session held on flood plain management excluded the matter of optimization of investment in flood control and flood plain zoning. Interest, discount rates, and regional benefits were discussed as well as political and institutional problems. The final session dealt with recommendations of a research program to improve the evaluation process. (Kriss-Cornell)

W71-03777

### WATERSHED PROJECTS.

Committee on Agriculture (U. S. House). Subcommittee on Conservation and Credit. For primary bibliographic entry see Field 06E. W71-03787

### 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

#### FACTORS INFLUENCING RURAL WATER PURCHASE,

Kentucky Water Resources Inst., Lexington.

Charles R. Rosenstiel.

Available from NTIS as PB-196 658, \$3.00 in paper copy, \$0.95 in microfiche. Technical report, Kentucky Water Resources Institute Research Report No 38, 1970. 45 p, 8 tab, 7 ref, 2 append. OWRR Project A-022-KY (9).

Descriptors: \*Social change, Social values, Social impact, Attitudes, Kentucky, Costs, \*Water users, \*Water utilization, Water rates, \*Water costs, Prices.

Identifiers: Water purchase, Water needs.

An analysis is presented of factors which influence domestic water purchase among residents of a rural Kentucky county who must purchase hauled water. The results of the analysis are compared with previous studies of factors which influence domestic water use by urban dwellers participating in a piped water distribution system. The results of the analysis of rural water purchase corroborate the findings from the studies of urban water use, showing that the amount of water purchased by a household is influenced by the socio-economic status of that household and by the price paid for water. As socio-economic status rises, domestic water purchase increases, and as the price of water increases the amount of water purchased decreases.

W71-03303

**A GROWING MARKET FOR WATER AND WASTEWATER TREATMENT EQUIPMENT,** Business and Defense Services Administration, Washington, D.C. Water Resources and Engineering Services Div.

For primary bibliographic entry see Field 05D. W71-03597

#### ON THE INCIDENCE OF INCOME REDISTRIBUTION,

Iowa State Univ., Ames.

J. Ronnie Davis.

Public Choice, Vol 8, No 2, p 63-74, Spring 1970.

Descriptors: \*Welfare economics, Decision making, Stability.

Identifiers: \*Income redistribution, \*Incidence, Game theory, Net payoff, Characteristic function, Marginal product.

The incidence of income redistribution is considered as a function of voting or fiscal decision making rules. Three general fiscal institutions are investigated to determine the relationship between fiscal decision making institutions and redistribution. They are the democratic fiscal institutions which allow all members one vote each, taxpayer fiscal institutions allowing only taxpayers a vote, and proportional taxpayers fiscal institutions where votes are in proportion to the amount of taxes paid. Game theory is used to discuss the implications for income redistribution within the three institutional rules. The results indicate that only the democratic rule can rely on individual voting to distribute income downward. The taxpayer and proportional rules redistribute in an inconsistent manner with the proportional rule generally redistributing income upward. The author concludes that in less than unanimous decision-making, some concern must be given to the incidence of income redistribution. There have been recent studies dealing with the distributional effects of water investment

## Cost Allocation, Cost Sharing, Pricing/Repayment—Group 6C

projects. This study provides a general framework to analyze the distributional aspects of government tax and investment policies. (Siegenthaler-Rutgers) W71-03600

**WATER RESOURCE ALLOCATION, EXTRA MARKET VALUES, AND MARKET CRITERIA: A SUGGESTED APPROACH,**  
Oregon State Univ., Corvallis.

For primary bibliographic entry see Field 06B.  
W71-03603

**A FURTHER NOTE ON THE COST IMPLICATIONS OF FLUCTUATING DEMAND,**  
Bowling Green State Univ., Ohio; and Rutgers - The State Univ., New Brunswick, N.J.  
Kerry V. Smith, and Joseph J. Seneca.  
*Journal of Financial and QUANITATIVE Analysis*, Vol 5, No 3, p 369-376, September 1970.

Descriptors: \*Flexibility, \*Demand function, Probability, Cost function, Inventory, Constraint. Identifiers: \*User costs, Production function, Taylor series.

The effect of fluctuating demand is discussed for a product on factor input level and production cost of the firm. Recent work by McKean has asserted that in order to estimate the cost of production of a product subject to fluctuations in demand, one must consider the entire distribution of outputs along with the static cost function. This paper reconsiders this problem in the context of flexibility. Flexibility is present when the entrepreneur maintains a range of factor inputs and minimizes the cost of output over the relevant part of the production function. In markets with variations in demand, the firm produces a probability distribution of outputs and minimizes a total cost function associated with the production of that probability distribution. The article shows that the static cost function and the variable output cost function are not identical with the same input mix. Accordingly, the use of the static cost function for firms with variability in demand will overstate the total cost of sub and superoptimum outputs and also distort average cost. The concept of flexibility is relevant to planning water supplies designed to meet wide variations in the demand for water use. (Siegenthaler-Rutgers)  
W71-03608

**INPUT CHOICES AND RATE OF RETURN REGULATION: AN OVERVIEW OF THE DISCUSSION,**

Princeton Univ., N.J.; and Yale Univ., New Haven, Conn.

William J. Baumol, and Alvin K. Klevorick.  
*The Bell Journal of Economics and Management Science* Vol 1, No 2, p 162-190, Autumn, 1970.

Descriptors: \*Economic efficiency, \*Rate of return, \*Government, Profit, Economic evaluation, Capital cost, Model studies, Management, Maximization, Mathematical study, Cost minimization, Demand.

Identifiers: \*Regulation, \*Capital-labor ratio, Averch-Johnson effect, Input proportions, Sales maximization, Regulatory lag.

Averch and Johnson demonstrated that rate of return regulation will modify the capital-labor ratio utilized by the profit-maximizing firm. This paper examines the substance of the discussion that has arisen concerning the Averch-Johnson model. The paper should be relevant to those water utilities subject to governmental regulation. It restates the relevant theorems and assertions and in addition provides several basic proofs. It then examines some related propositions that have been developed and discusses some work currently in progress in the area. In the last section the authors conclude that there are dangers to economic efficiency in the rate of return approach to rate regulation but that the phenomenon which arises from the Averch-Johnson theorem may not be of great significance in practice. (Murphy-Rutgers)

W71-03609

**WATER ALLOCATION IN AN URBAN FRAMEWORK,**  
West Virginia Univ., Morgantown.  
For primary bibliographic entry see Field 06D.  
W71-03613

**PROBLEMS IN PUBLIC EXPENDITURE ANALYSIS,**  
Brookings Institution, Washington, D.C.  
Samuel B. Chase.  
Washington, D.C., the Brookings Institution, 1968, 269 p.

Descriptors: \*Government, \*Benefit-cost analysis, \*Economic evaluation, Prices, Income, Time, Transportation, Social aspects, Economic efficiency, Government supports, Recreation, Taxes, Planning, Pollution.

Identifiers: Public expenditure analysis, \*Income distribution, \*Shadow prices, Travel time, Mortality, Cotton prices.

The book contains five papers and ten commentaries resulting from a conference on the problems of government expenditure analysis in September 1966. The first paper considers the difficulties of evaluating benefits and costs, particularly when private market prices cannot be used directly. The next two papers deal with the problems of valuing the savings of human time and human life. The value of time differs not only among persons and over each person's life span, but also among different uses and hours of the day. To determine the values put on reduced risk the author recommends the intensive interview technique to determine what the individual would be willing to pay for specified reductions in mortality probabilities. The next paper deals with the problem of income distribution effects and benefit cost analysis. It is shown that distributive effects must be considered along with traditional efficiency measures of expenditure programs and two methods for their inclusion are presented. The last paper discusses the distribution of benefits from cotton price supports. The discussions of these papers should aid in evaluating government water resources expenditures. In addition, the specific applicability of a number of papers to the evaluation of water supply and recreation benefits should provide specific interest to the water researcher. (See also W71-03615) (Murphy-Rutgers)  
W71-03614

**INCOME REDISTRIBUTION EFFECTS AND BENEFIT-COST ANALYSIS,**  
Wisconsin Univ., Madison.

Burton A. Weisbrod.  
In: *Problems in Public Expenditure Analysis*, Washington, D.C., the Brookings Institution, 1968, p 177-209.

Descriptors: \*Income, \*Cost-benefit analysis, \*Economic efficiency, \*Decision-making, Government, Economic evaluation, Optimization, Welfare economics, Population, Recreation, Model studies, Water resource development.

Identifiers: \*Income distribution, \*Allocative efficiency, Distributional criteria, Weights.

This paper attempts to find a means by which economists can improve the quality of decisions on public expenditures through incorporation of the income distribution effects as well as the allocative-efficiency effects into the benefit-cost analysis of public projects. One device would be to determine how the total benefits and costs of each project would be divided among various population groupings. A second method would be to deduce the value judgements concerning the distribution of income which is implied by decision choices and then assign weights to the distributional effects. The author argues that consideration of the income distribution effects of public investments will improve the quality of advice provided by economic analysis. The paper discusses these in the context of

several water resource projects, and the author shows that their specific inclusion in the economic evaluation could improve the decision-making process. (See also W71-03614) (Murphy-Rutgers)  
W71-03615

**THE SECOND-BEST CASE FOR MARGINAL COST PRICING,**  
Electricity Council, London (England).

R. Turvey.  
In: *Public Economics*, London, Macmillan, 1969, p 336-343.

Descriptors: \*Marginal cost pricing, \*Resource allocation, Economic efficiency, Interest rate, Investment decision, Depreciation.

Identifiers: \*Public enterprise, \*Social cost, Social discount rate, Capital rationing, \*Second-best case, Shadow pricing, Capital intensity, Book value.

Economic efficiency and the conditions for efficient resource allocation for public enterprises are discussed. The optimum conditions for economic efficiency occur when all prices are equal to the long run marginal cost of goods and services and when the interest rate used in decision-making is uniform throughout the economy and equal to the social discount rate. The problem of the second-best or sub-optimization for the public enterprise sector is analyzed. The marginal cost pricing rule is not applicable and therefore new rules are worked out to achieve sub-optimization. These rules are concerned with the following issues: the choice of inputs by a public enterprise of how to produce a set of outputs, and the determination of the relative prices of the outputs. For the first problem, the conclusion is that public enterprises should minimize costs calculated with market prices of inputs and corrected for divergence of social cost on the second issue, the prices of public enterprise products should equal long-term marginal cost within their sector and be proportional to sales outside the sector for a group of substitutes. This article is relevant for water studies concerned with the theoretical foundations of pricing problems in the public goods area. (See also W71-03616) (Siegenthaler-Rutgers)  
W71-03618

**POLITICAL AND BUDGETARY CONSTRAINTS: SOME CHARACTERISTICS AND IMPLICATIONS,**

Ministry of Aviation, London (England).  
P. D. Henderson.  
In: *Public Economics*, London, Macmillan, 1969, p 310-325.

Descriptors: \*Political constraint, \*Budgetary constraint, Economic efficiency, Cost, Risk, Welfare economics, Systems analysis.

Identifiers: \*Second-best rules, Decision rules, Economic growth, Shadow pricing.

Political and budgetary constraints are discussed in relation to other aspects of the public economy and to a wide range of policy issues. For economic efficiency and consistency, the choice of objective and the form of the constraints should be determined at high political levels to avoid piecemeal decisions. Flood control in the United States is cited as a violation of this principle. Constraints should be formalized and made explicit to aid in quantifying the implications of alternative policies in order to ensure their role in the decision-making process. The author suggests two methods of ensuring that political and budgeting constraints on expenditures programs are well designed. Within individual programs, the use of program budgeting and systems analysis is important. With respect to choice of programs, objective discussion without excessive political interference of expenditure allocation should occur. The article is important to water investment studies concerned with the political constraints to public decision making. (See also W71-03616) (Siegenthaler-Rutgers)  
W71-03620

## Field 06—WATER RESOURCES PLANNING

### Group 6C—Cost Allocation, Cost Sharing, Pricing/Repayment

**PURE THEORY OF PUBLIC EXPENDITURE AND TAXATION,**  
Massachusetts Inst. of Tech., Cambridge.  
Paul A. Samuelson.  
In: *Public Economics*, London, Macmillan, 1969, p 98-123.

Descriptors: \*Public expenditure, Taxation, Resource allocation, Social welfare, Welfare economics.  
Identifiers: \*Public good, \*Benefit theory, Ability-to-pay, Consumption externality, Game theory, Consumer surplus, Marginal utility of money, Pareto optimal, Algorithm.

The theory of optimal resource allocation of public and social goods is related to previous public finance writing. A public good is defined as one with the property of a consumption externality (that is, entering into two or more person's preference function simultaneously). Under this definition, there are pure private goods where the market mechanism operates and the whole field of public goods. A pseudo-demand analysis is presented for public and private goods with utility maximized subject to a state provided lump sum income. It is found that pseudo-laissez-faire does lead to Pareto optimality but not ethically maximum welfare. The tax theory relying on voluntarism is found to be false. It was impossible to separate benefit-allocation and redistribution-equity considerations. The author cites a need for analytical studies of public goods using algorithmic solutions immune to bilateral monopoly or game theoretic objections. The article is relevant to theoretical studies of the public good nature of water resource projects. (See also W71-03616) (Siegenthaler-Rutgers)  
W71-03621

**THE DISTRIBUTION OF THE BURDEN OF SEWER USER CHARGES UNDER VARIOUS CHARGE FORMULAS,**  
McMaster Univ., Hamilton (Ontario).  
James A. Johnson.  
The National Tax Journal, Vol XXIX, No 3, p 472-485, December 1969.

Descriptors: \*Cost sharing, Economic efficiency, Resource allocation, Marginal costs, Revenue, Regressivity.  
Identifiers: \*User charge, \*Sewer service charge, Burden, Equity, Externalities, Social cost, Social benefits.

This paper analyzes one type of user charge—the sewer service charge in terms of equity, resource allocation, revenue, and administrative objectives. The model divides users into residential, commercial and industrial categories. The burden for each category is then computed under ten sewer charge formulas by applying the charges to a model of a large eastern city. The measure of burden is the percentage of revenue that would be paid by categories of users under each of the sewer charges. The results indicate a large variance in the distribution of the revenue borne among the three categories of users. The residential share is highest when there is a flat or minimum fee with the commercial share being largest when the charge is based on property value. The industrial share is greatest if the charge basis is sewage strength but it is also high for a fixed rate. It is difficult to determine equity and resource allocation objectives which are satisfied in a formula. Hence, formula choice depends on the relative weights placed on the four objectives. The most efficient formulas by objective are: for equity, property assessment; for resource allocation, rate per unit of volume and strength; for revenue, all formulas, and for administration, flat fee and property assessment. (Siegenthaler-Rutgers)  
W71-03629

**POLLUTION, PROPERTY AND PRICES,**  
Toronto Univ., (Ontario).  
J. H. Dales.  
Toronto, University of Toronto Press, 1968. 111 p.

Descriptors: \*Prices, \*Waste disposal costs, Decision-making, Cost benefit analysis, Economic efficiency.  
Identifiers: \*Property rights, \*Pollution costs, Net benefit, Social cost, User charge, Subsidy, Regulatory agencies.

The author considers pollution as a social problem involving collective decision-making. The costs of waste disposal are divided into pollution prevention costs and pollution costs. Cost-benefit analysis is illustrated as a method of decision-making about different pollution policies that are selected through political decision-making. The treatment of air and water as unrestricted common property is questioned with a more sophisticated approach suggested to property rights. The best strategy, the author suggests, for reducing waste disposal costs is a system of charging for user rights with the Government setting the level of permissible pollution. This book is relevant for water resource planners concerned with resource allocation. (Siegenthaler-Rutgers)  
W71-03630

**ZERO-BASE BUDGETING,**  
Texas Instruments, Inc., Dallas.  
Peter A. Pyhr.  
Harvard Business Review, Vol 48, No 6, p 111-121, Nov-Dec 1970.

Descriptors: \*Budgets, \*Management, \*Resource allocation, Economic evaluation, Costs, Alternatives, Benefits, Production, Planning, Decision-making.  
Identifiers: \*Support expense, \*Zero base, Ranking, Voting, Cash flow.

Budgeting of future expenses other than those in the category of direct labor, materials and overhead expense is discussed. The budget process is described at Texas Instruments which, instead of adjusting the existing budget for the upcoming year, starts from a zero base viewing all its activities and priorities afresh and creates a new set of allocations for the upcoming budget year. The experiences of this company, as well as the budgeting principles involving cost-benefit analysis, are directly transferrable to the area of water resource budgeting. The procedure provides: (1) management with a definite means of control on support allocations of all kinds; (2) a method for describing all support expense minutely; (3) a means for classifying the alternatives to each; and (4) a method for sorting all alternatives by both importance and priority. (Murphy-Rutgers)  
W71-03644

**RATE OF RETURN ON INVESTMENT RISK,**  
Massachusetts Inst. of Tech., Cambridge.  
Paul H. Cootner, and Daniel M. Holland.  
Bell Journal of Economics and Management Science, Vol 1, No 2, p 211-226, Autumn 1970.

Descriptors: \*Risk, Regression analysis, Marginal utility, Probability distribution.  
Identifiers: \*Rate of return, \*Capital market, Book value, Risk averter, Capitalization, Skewness.

The study was undertaken to find an empirical basis for the Supreme Court ruling that a regulated utility should earn a rate of return equal to that of unregulated firms given corresponding risks. Business risk is defined as functionally related to earnings variability. The authors tested the hypothesis that there is a positive association between business risk and rate of return using regression analysis to explain the variation of industry rate of return with risk. The results are significant and indicate a positive relationship exists for both samples of companies and industries. The model explains about 30% of the variability in the rate of return among companies and industries. The results are considered in the light of recent research on financial risk. This article is of general relevance to rate of return issues involving water utilities. (Siegenthaler-Rutgers)  
W71-03645

**TECHNIQUES OF PROJECT APPRAISAL,**  
Chicago Univ., Ill.  
For primary bibliographic entry see Field 06B.  
W71-03646

**THE IMPACT OF INFLATION ON CAPITAL BUDGETING DECISIONS,**  
Boston Univ., Mass.  
Earl M. Foster.  
Quarterly Journal of Economics and Statistics, Vol 10, No 3, p 19-24, Autumn 1970.

Descriptors: \*Inflation, Investment, Risk, Simulation analysis, Depreciation.  
Identifiers: \*Capital budgeting, \*Net present value, \*Monetary debtor-creditor hypothesis, Internal rate of return, New cash flow.

Most previous research on the effects of inflation on corporations has been concerned with wealth distribution rather than with the financial decisions which must be made. This article develops a formula for evaluating investment proposals incorporating the effects of changes in the price level. To allow for inflation, the net present value formula is modified into a real value concept by discounting for the time value of money and the percentage increase in its purchasing power. The formula is further refined by distinguishing between costs which are sensitive to changes in the price level and those which are entirely independent (an indirect consideration of the monetary debtor-creditor hypothesis). This hypothesis states that during periods of inflation net monetary debtors gain at the expense of net monetary creditors. The relative real profitability of different cost structures and means of finance for capital investment along with risk implications are considered in the formula. This discussion is relevant for water investment studies concerned with capital budgeting. (Siegenthaler-Rutgers)  
W71-03647

**INTEREST RATE POLICY FOR THE EVALUATION OF FEDERAL PROGRAMS,**  
Harvard Univ., Cambridge, Mass.  
For primary bibliographic entry see Field 06B.  
W71-03650

**ON THE OPPORTUNITY COST OF BORROWING,**  
Chicago Univ., Ill.  
Arnold Harberger.  
In: *Economic Analysis of Public Investment Decisions: Interest Rate Policy and Discounting Analysis*, Hearings of the Joint Economic Committee, July 30, 31, and August 1, 1968, Washington, Government Printing Office, p 57-65, 1968.

Descriptors: \*Economic evaluation, \*Interest rate, Discount rate, Taxes, Depreciation.  
Identifiers: \*Opportunity cost, \*Public borrowing, Social cost, Capital market, Rate of return, User charge, Weighted average.

The report of the Comptroller General in the evaluation of public investment is considered. The report advocates that the cost of government borrowing should include not only the interest actually paid by the Government, but also an adjustment factor for the taxes which the government loses on the income that would have occurred if an investment project was not undertaken. This adjustment factor accounts for the social costs resulting from the borrowing. The author finds that the report stresses the cost to the Treasury of incremental borrowing but neglects the costs to the economy. Government borrowing may displace corporate investment, noncorporate investment, residential construction, and purchases of consumer durables. To find the opportunity cost of public borrowing, a weighted average of the rates of return applying in all relevant sectors of the private economy is used with the weights reflecting the degree of displacement in each private sector. The cost of Government borrowing is best measured by the rate of interest on Government bonds plus the tax loss on the

income foregone as a result of displaced private investment. In the calculation of opportunity costs, the report omits property, sales, and excise taxes. The author recalculates the social opportunity cost correcting for the omissions and derives higher results. This article is relevant for water studies concerned with the economic evaluation of water investment project. (See also W71-03649) (Siegenthaler-Rutgers) W71-03651

**COST/EFFECTIVENESS ANALYSIS: ITS TASKS AND THEIR INTERRELATION,**  
General Electric Co., Santa Barbara, Calif. TEM-PO.

For primary bibliographic entry see Field 06A.  
W71-03654

**THE ROLE OF COST UTILITY ANALYSIS IN PROGRAM BUDGETING,**  
Rand Corp., Santa Monica, Calif.  
For primary bibliographic entry see Field 06B.  
W71-03659

**OPERATIONS AND MAINTENANCE COSTS OF IRRIGATION DISTRIBUTION SYSTEMS,**  
Idaho Univ., Kimberly. Twin Falls Branch Experiment Station.  
C. E. Brockway, and A. E. Herbig.  
National Irrigation Symposium Paper, American Society of Agricultural Engineers, p HH1-10, Nov 12, 1970. 10 p 2 fig, 4 tab, 2 ref.

Descriptors: \*Distribution systems, \*Maintenance costs, \*Operating costs, \*Estimating equations, Water conveyance, \*Irrigation systems, Irrigation districts, Irrigation canals, Pipelines, Irrigation operation and maintenance, Project planning, California.  
Identifiers: United States (Northwest).

Operation and maintenance costs of twenty-five irrigation districts in the Northwest and California were evaluated to determine differences in costs between open channel distribution systems and pipe systems. Parameters affecting costs for the different system types are outlined. Personnel requirements for administration, water control and maintenance functions are presented. Large variations in parameters affecting costs prevents the selection of any one district as typical of a specific type of system. A multiple regression analysis utilizing parameters which can be easily measured on existing systems and easily determined for proposed systems was performed. The resulting predictive equations indicate the feasibility of the approach however, increased sample size is desirable.  
W71-03779

## 6D. Water Demand

**PRE-IMPOUNDMENT RECREATIONAL USE PATTERN AND WATERFOWL OCCURRENCE IN THE SAYLORVILLE RESERVOIR AREA,**  
Iowa State Water Resources Research Inst., Ames.  
For primary bibliographic entry see Field 06B.  
W71-03373

**WATER MANAGEMENT RESEARCH GROUP: FIRST REPORT (1969).**  
Organization for Economic Co-Operation and Development, Paris (France).  
For primary bibliographic entry see Field 06A.  
W71-03445

**DETERMINATION OF THE SIGNIFICANCE OF VARIABLES AFFECTING RESIDENTIAL WATER CONSUMPTION,**  
Puerto Rico Univ., Mayaguez. Water Resources Research Inst.  
Appu Kuttan.

Available from NTIS as PB-196 873, \$3.00 in paper copy, \$0.95 in microfiche. Technical Completion Report, Water Resources Research Institute, Mayaguez, Puerto Rico, September, 1970. 19 p, 1 tab, 20 ref. OWRR Project A-022-PR (1).

Descriptors: \*Water demands, \*Water consumption, \*Consumptive use, Water utilization, \*Municipal water, \*Water supply, Statistical methods.  
Identifiers: \*Residential water consumption.

The purpose of this project was to identify the significance of variables affecting residential water consumption in the case of private urbanization dwellings in Puerto Rico. Separate sections deal with a survey of variables affecting residential water consumption and response variables for residential water consumption; design of a statistical experiment; experimentation and data gathering; analysis of data; and conclusions and recommendations. It is concluded that the number of bathrooms has the largest effect on per capita water consumption in the case of private urbanization homes in Puerto Rico. This study does not indicate that property value is a significant variable as believed by many. Conclusions are limited by the fact that no variable was found to be significant statistically. It is also seen that the error variance is very large. Recommended for investigation is an approach to account for two-factor interactions, i.e., interaction effect between variables such as, number of bedrooms and number of automobiles.  
W71-03517

**PAB PROCESS FOR ADVANCED WASTE TREATMENT,**  
Iowa State Univ., Ames. Engineering Research Institute.  
For primary bibliographic entry see Field 05D.  
W71-03519

**LECTURES ON WATER MANAGEMENT.**  
Dept. of Environmental Engineering Science, Johns Hopkins Univ., Baltimore, Md.  
For primary bibliographic entry see Field 06B.  
W71-03594

**WATER AND CITIES AND INDUSTRIES,**  
Hazen and Sawyer, New York.  
Richard Hazen.  
Lectures on Water Management, Water Management Seminars, Johns Hopkins University, Baltimore, Maryland, October 26, 1964, p 25-34.

Descriptors: \*Industrial use, \*Municipal water, Water reuse, Water works, Water rates, \*Water utilization.  
Identifiers: Consolidated Edison Company of New York, Upland water, Port of New York Authority, Washington Suburban Sanitary Commission.

Municipal water consumption is compared to industrial use of water. The author described in general terms the quantity of water used by each, the rates each paid and the specific ways each used the water. Also discussed was the relative advantage of upland water supplies (i.e. unpolluted supplies) to reclaimed water. The author advocated identification and exclusion of harmful substances before entrance into the water supplies rather than filtration afterwards. Included also in this brief paper was a rationale for 'overbuilding water works'-a charge which the author (himself an engineer) explains is often directed against engineers who have constructed works larger than what is immediately needed. (See also W71-03594) (Holmes-Rutgers)  
W71-03595

**A FURTHER NOTE ON THE COST IMPLICATIONS OF FLUCTUATING DEMAND,**  
Bowling Green State Univ., Ohio; and Rutgers - The State Univ., New Brunswick, N.J.  
For primary bibliographic entry see Field 06C.  
W71-03608

**WATER ALLOCATION IN AN URBAN FRAMEWORK,**  
West Virginia Univ., Morgantown.  
Patrick Mann.  
Nebraska Journal of Economics and Business, Vol 9, No 1, p 3-17, Winter 1970.

Descriptors: \*Water supply, \*Water demand, Decision making, Water resource management, Price elasticity, Watershed development, Salt water diversion.  
Identifiers: \*Water division, Sewage reclamation, Sewer charge.

The impact is considered of rapid urbanization in the United States on the future water supply. Large population growth has resulted in decision making aimed toward increasing regular water supplies via the alternatives of saltwater conversion, watershed development, and geographical diversion of water supply. The main issue in water supply is the necessity to compare all rational alternatives for meeting the increase in demand for water services. The relative costs of these alternatives must be considered as well as the costs of metering sewage reclamation and rate increases. The use of rate increases to ration water supply is a policy alternative which has been overlooked. The author contends that rational pricing may be more costly as an alternative than the expansion of water supplies through water diversion. Water supply and pricing must be analyzed in the larger framework of the problems of water quality and water-use management. (Siegenthaler-Rutgers)  
W71-03613

**POPULATION AND NATURAL RESOURCES,**  
Carnegie Institution of Washington, D.C.  
Edward Ackerman.  
In: Readings in Resource Management and Conservation, Chicago, University of Chicago Press, 1965, p 127-152.

Descriptors: \*Population, \*Natural resources, \*Conservation, Technology, Economies of scale, Wastes, Irrigation, Evaporation, Water supply, Budgets, Sea water, Precipitation, Management, Water quality.  
Identifiers: \*Malthus, \*Manufacturing, Productive life, Culture, Resource stability, Consumption.

This author studies the relationship between demography and resources through the use of an equation relating the demand and supply of natural resources. The article involves an extended discussion of the variables to be included in this equation. Correlation between population and the physical environment, geographical incidence of certain cultural factors, effects of institutional inheritance and the stability and quality of the resources are some of the topics treated. In addition certain 'feedback' items are discussed and all resource and culture attributes are studied as they correlate with demographic attributes other than number. Finally, all of the analysis is applied to a study of the world's population. In the concluding section on neo-Malthusian and anti-Malthusian views, two different prospects for resource adequacy are projected for the next decade, these being those for China-type countries and those for European-type countries. Co-ordinated population-resource-technology studies are suggested to deal with the problems of these two types of countries for the purpose of arriving at an understanding of what the limits of the earth may amount to in the immediate future. Many of the problems in the water resource area are common to all natural resources. Thus, this article should be of use to the water planner. (See also W71-03631) (Murphy-Rutgers)  
W71-03638

**USER RESPONSE IN OUTDOOR RECREATION: A COMMENT,**  
Cornell Univ., Ithaca, N.Y.  
For primary bibliographic entry see Field 06B.  
W71-03664

## Field 06—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

#### 6E. Water Law and Institutions

##### SIMPSON V MARTIN (TITLE DISPUTE TO RIPARIAN LAND DEPENDS ON WHETHER RIVER CHANGED COURSE BY ACCRETION OR AVULSION).

298 SW 861-863 (Ark 1927).

Descriptors: \*Arkansas, \*Boundaries (Property), \*Avulsion, \*Riparian land, Riparian waters, Riparian rights, Rivers, Navigable rivers, Bank erosion, Accretion (Legal aspects), Channel erosion, Prescriptive rights, Land tenure, Real property, Legal aspects, Judicial decisions, Adjudication procedure.

Plaintiff riparian owner sued defendant riparian owner to quiet title to river front property. The record title showed that plaintiff's land was north of the river and defendant's land was south of the river. Plaintiff contended that the river had gradually moved south, the south bank being gradually washed away and the north bank moving south by accretions to plaintiff's land until the accretions to his land occupied what used to be defendant's land south of the river. Plaintiff also claimed adverse possession of the lands in question. Defendant contended that there was no accretion to the north bank or erosion of the south bank but that the course of the river had changed suddenly by avulsion and that the land next to plaintiff's was the same originally conveyed to defendants. Affirming a judgment for defendant, the court noted that property boundaries are presumed permanent, and one seeking to change those boundaries has the burden of proving that the change in the river's course was due to accretion rather than avulsion. The court reviewed the conflicting evidence and held that the lower court's finding that the land was not an accretion was not against the weight of the evidence. The court also noted that plaintiff did not exercise any adverse use of the entire property. (Liptak-Florida)  
W71-03338

##### ARKANSAS POWER AND LIGHT CO V ORR (LIABILITY FOR FLOOD DAMAGE CAUSED BY NEGLIGENT FLOOD GATE OPERATION).

11 SW2d 761-762 (Ark 1928).

Descriptors: \*Arkansas, \*Dams, \*Flood damage, \*Floodgates, Rivers, Water injury, Hydroelectric plants, Legal aspects, Riparian waters, Reservoir operation, Judicial decisions, Adjudication procedure, Riparian land.

Plaintiff riparian owner brought action against defendant power company to recover for flood damage to plaintiff's lands and crops. The damage was caused by water released from defendant's dam. Plaintiff contended that defendant was negligent in operating its floodgates, thereby flooding plaintiff's land and destroying his crop. Affirming a judgment for plaintiff, the court held that the conflicting evidence as to defendant's negligence was properly submitted to the jury. (Liptak-Florida)  
W71-03352

##### LOUISVILLE AND N RR V VANDIVER (DIVERSION OF RIVER CAUSED BY OBSTRUCTION).

238 Ky 846, 38 SW2d 965-967 (1931).

Descriptors: \*Kentucky, \*Railroads, \*Sand bars, \*Alteration of flow, Flow around objects, Bridges, Piers, Susidence, Erosion, Flood damage, Water injury, Adjudication procedure, Legal aspects, Judicial decisions, Rivers, Streams, Riparian land, Bank erosion, Rocks, Floods, Diversion.

Plaintiff riparian landowner sued defendant railroad for damages from flooding and erosion caused by defendant's obstruction of a river. Defendant

had erected a bridge over a creek at a point just before it flowed into the river upon which plaintiff's land bordered. To prevent the bridge piers from subsiding, defendant had placed large rocks in the creek. Unprecedented rainfall caused these rocks to wash onto a sandbar in front of plaintiff's land. The sandbar was previously seasonal, being washed away by heavy rainfall and gradually building up in the drier seasons, but the rocks now prevented it from washing away. The sandbar thus grew increasingly larger and began to divert the river, causing it to flood and erode plaintiff's land. Defendant contended that the injury was caused by the unprecedented rain, but the court noted that defendant's rocks were a 'but for' cause of the injury and refused to find error in the lower court's denial of a motion for a directed verdict. The lower court's judgment for plaintiff was affirmed. (Hart-Florida)  
W71-03353

##### POINT PRAIRIE HUNTING AND FISHING CLUB V SCHMIDT (TITLE DISPUTE TO DRY RIVER BED BETWEEN ISLAND AND MAINLAND).

44 SW2d 73-76 (Mo 1931).

Descriptors: \*Missouri, \*Ownership of beds, \*Boundaries (Property), \*Accretion (Legal aspects), Rivers, Missouri River, Channels, Land tenure, Islands, Beds, River beds, Boundary disputes, Real property, Legal aspects, Judicial decisions, Adjudication procedure, Riparian land, Prescriptive rights, Surveys.

Plaintiff sued to quiet title to a dry river bed between plaintiff's island on the Missouri River and defendant's property on the mainland. The bed had been formerly a slough or arm of the River but had been gradually filled up so that portions of it were on a level with the island and mainland. Plaintiff claimed title to the island and to the land out to the center line of the old channel between the island and the mainland. Defendant contended that plaintiff's title only conveyed to the boundaries of the island and that the entire dry river bed vested in the mainland owner. Affirming a judgment for plaintiff, the court found that, since the county had already conveyed a portion of the bed to plaintiff, defendant's patent from the county could not have conveyed title to the entire river bed. Therefore, each party owned to the center line of the old channel. The court also noted that it was proper for the lower court to appoint a commission to determine the exact location of the center line of the old channel. (Liptak-Florida)  
W71-03358

##### BAXTER V DAVIS (SALE OF RIPARIAN LAND).

252 Ky 525, 67 SW2d 678-682 (1934).

Descriptors: \*Kentucky, \*Riparian land, \*Non-navigable waters, \*Boundaries (Property), Claims (Contracts), Flooding, Land use, Real property, Rivers, Acreage, Adjudication procedure, Judicial decisions, Legal aspects, Contracts, Land tenure.

Plaintiff vendor of riparian land sued defendant vendee to recover the amount owed on a contract for the sale of land. Defendant admitted the contract and the amount but contended that plaintiff had fraudulently represented the property as 7 1/2 acres, when it was only 5 acres, and as not subject to overflow. The court observed that the river on which the land bordered was non-navigable, and therefore the property boundaries extended to the thread of the stream, including more than 7 acres. Upon perusal of conflicting evidence, the chancellor had found that plaintiff either had not represented the land as not subject to overflow or that such a representation was substantially true. The court, stating that lower court's findings were not clearly erroneous, affirmed the lower court's decision for plaintiff. (Hart-Florida)  
W71-03363

##### WABASH AND ERIC CANAL LANDS (DUTY OF STATE AUDITOR TO EXECUTE PATENTS TO ORIGINAL PURCHASERS OR GRANTEES).

Ind Ann Stat secs 62-901-62-914 (1962).

Descriptors: \*Indiana, \*Land tenure, \*Real property, \*Canals, State governments, Land, Legislation, Inland waterways, Administration, Governments, Legal aspects, Federal government, United States, Jurisdiction.

Identifiers: \*Patents (Land).

The state auditor must execute patents to the original purchasers or their grantees for all Wabash and Erie Canal lands. Filing procedures are set forth. A patent deed of canal lands from the state auditor vests title in the grantee to the same extent as if a valid deed had been made to the original purchaser for consideration, but such deed does not affect the validity of prior interests or liens on the property. Disputes as to ownership of canal lands are within the jurisdiction of the circuit and superior courts in the county in which the lands are located. The purpose of this act is to correct errors in former conveyances, and no taxes paid may be recovered on the ground that title was formerly in the state. (Dye-Florida)  
W71-03365

##### BECK V KULESZA (LANDOWNER'S RIGHT TO DIVERT STREAM).

156 A 346-50 (Sup Ct Del 1926).

Descriptors: \*Delaware, \*Obstruction to flow, \*Artificial watercourses, \*Alteration of flow, Riparian rights, Boundaries (Property), Riparian land, Riparian waters, Diversion, Streamflow, Streams, Reasonable use, Natural streams, Watercourses (Legal), Banks, Legal aspects, Judicial decisions, Tailrace, Flooding.

Plaintiff and defendant owned adjoining property separated by a stream. A tailrace on plaintiff's property ran parallel and below the stream. Defendant by placing debris in the stream's course diverted water which normally flowed in the stream into the tailrace. When the tailrace overflowed and flooded plaintiff's land, plaintiff sought damages against defendant. Defendant contended that plaintiff had originally constructed the stream course to divert water from the tailrace, the natural course, into the stream. Therefore, defendant argued that he was justified in obstructing streamflow and diverting the water back into the natural course. The Delaware Superior Court, in charging the jury, stated that plaintiff, in order to recover, had to provide that the stream was a natural watercourse. A riparian owner who diverts a natural stream from its accustomed channel is liable for damages from resulting overflow onto his neighbors' land. However, riparian owners can within reasonable time divert a stream from an artificial course through their lands back to a natural course. (Powell-Florida)  
W71-03366

##### KINCAID V UNITED STATES (DUTY OF UNITED STATES TO CONDEMN LAND TO BE FLOODED BY DIVERSION CHANNEL).

35 F2d 235-248 (WD La 1929).

Descriptors: \*Louisiana, \*Levees, \*Condemnation, \*Federal government, Flooding, Damages, Governments, Flood control, Remedies, Legal aspects, Judicial decisions, Flood plains, Eminent domain, Compensation, State governments, Mississippi River, Political aspects, Legislation, United States, Adjudication procedure.

Plaintiff landowner sought to enjoin defendants Secretary of War, Chief of Engineers, and Mississippi River Commission from flooding his land. Plaintiff's land was situated between two proposed levees and within a channel through which a portion of the waters of the Mississippi River were to be diverted. Plaintiff contended that defendants

could not flood his land without first having followed the proper condemnation procedures. Defendants contended that because state law did not require the state to pay for property taken for levees, the federal government was also protected by the state statute. The court held that: (1) a state statute exempting the state from payment for property taken for levees does not exempt the federal government; (2) although the federal government has the authority to construct improvements on and in navigable waters and has police powers analogous to state police powers, a landowner has standing to sue to prevent the government from taking his land for such improvements without condemnation; and (3) riparian owners are protected from undue interference with their riparian rights by alteration of streamflow. (Quesada-Florida) W71-03369

**SILVER SPRINGS PARADISE CO V RAY  
(LAND PATENT AS NOT DEPRIVING PUBLIC  
OF RIGHT TO USE NAVIGABLE WATERS).**

50 F2d 356-360 (5th Cir 1931).  
Descriptors: \*Florida, \*Public rights, \*Navigable waters, \*Ownership of beds, Streams, Public benefits, Federal government, Judicial decisions, Legal aspects, Riparian rights, Riparian land, Riparian waters, Public lands, United States, Beds, Beds under water, Relative rights, Land tenure, Springs.  
Identifiers: Patents (Land).

Plaintiffs' predecessor in title had acquired a federal patent covering land contiguous to a navigable stream. Plaintiffs operated glass-bottom boats on a portion of the stream known as Silver Springs. Defendant company acquired land near plaintiffs' land and operated a rival glass-bottom-boat business on the same portion of the stream. Plaintiffs sought to enjoin defendant's operations. Plaintiffs claimed that they had, by virtue of the patent which included land that was submerged by the navigable stream, exclusive rights to operate on the navigable stream. Defendant contended that, because the United States held the title in trust to all navigable stream-beds within the territory of Florida, plaintiff did not acquire any title to submerged lands through his predecessor's patent. The Fifth Circuit Court of Appeals held that defendant's operation on navigable waters was an exercise of the public right of navigation. Consequently, plaintiff could not enjoin defendant's activities, notwithstanding plaintiffs' ownership of the submerged lands. The land patent did not deprive the public of the right to use the navigable waters covering land granted by the patent. Plaintiff acquired title to submerged lands subordinate to the public right. (Powell-Florida)  
W71-03370

**BURKE V COMMONWEALTH (TITLE TO  
ACCRETIONS WHERE DEED CONVEYS 'TO  
THE OCEAN').**

283 Mass 63, 186 NE 277-280 (1933).

Descriptors: \*Massachusetts, \*Accretion (Legal aspects), \*Breakwaters, \*Boundary disputes, Oceans, Legal aspects, Judicial decisions, Remedies, Local governments, Coastal structures, Shore protection, Boundaries (Property), Riparian land, Land tenure, Shores, Beaches, Navigable waters, High water mark, Low water mark, Seashores, Adjudication procedure.

Plaintiff sought to register title to an oceanfront lot and to land that accreted thereto as the result of the erection of breakwaters by defendant Commonwealth. Defendant town contended that the accreted land belonged to it. Neighboring landowners contended that they were entitled to an amount of beachfront proportioned to the frontage of their original lots. The Supreme Judicial Court of Massachusetts affirmed a judgment for plaintiff. Plaintiff's deed conveyed title to the 'ocean'. Monuments govern over measurements in describ-

ing a lot's boundaries. Where accretions occur, the line of riparian ownership follows the changing water line. The court stated that the side lines should be at right angles to the low water mark. Defendant received none of the accretions. The other landowners, though now cut off from the new natural beach, were entitled only to the breakwater. Owners of upland without title to adjacent flats may be cut off from the beach by construction in aid of navigation. (Morris-Florida)  
W71-03396

**TRUSTEES OF NEWPORT CENTER V NILES  
(WATER COMPANY'S DUTY TO MAINTAIN  
WORKS AND ADEQUATE SUPPLY).**

146 A 71-72 (Vt 1929).

Descriptors: \*Vermont, \*Administrative agencies, \*Public utilities, \*Water supply, Water quality, Domestic water, Springs, Watercourses (Legal), Water sources, Pipelines, Maintenance, Repairing, Legal aspects, Judicial decisions, Administration, Governments, Local governments, Water works, Water demand.

Plaintiff trustees of a village petitioned the Public Service Commission of Vermont to compel defendant water-company owners to repair unsatisfactory waterworks and to obtain an additional source of water supply. The Commission issued an order directing defendants to correct their deficiencies and to obtain the new source of water supply. Defendants appealed, and the Supreme Court of Vermont reversed and remanded. Evidence showed that the water system was out of repair. However, it was not shown that a new source of water supply was necessary to enable defendant to furnish customers with an adequate supply of wholesome water. The Commission exceeded its jurisdiction in ordering an additional source of water where the evidence did not show the need for one. (Duss-Florida)  
W71-03480

**MCGILL V THRASHER (OWNERSHIP OF  
ACCRETIONS IN RIVER BED BETWEEN  
ISLAND AND MAINLAND).**

221 Ky 789, 299 SW 955-957 (1927).

Descriptors: \*Kentucky, \*Ownership of beds, \*Accretion (Legal aspects), \*Islands, Rivers, Streams, Navigable waters, Non-navigable waters, Ohio River, Banks, Bank erosion, Land tenure, Prescriptive rights, Boundaries (Property), Boundary disputes, Riparian rights, Riparian waters, Riparian land, State governments.

Plaintiff owned an island in the Ohio River. The island had greatly enlarged by accretion, extending it upstream and connecting it to the shore. Plaintiff sued defendant riparian owner to quiet title to the accretion opposite defendant's upland, and a second upland owner sued to eject plaintiff from the accretion connected to his property. The Court of Appeals of Kentucky noted that riparian owners own to the middle of the stream, including any land formations, and the same rights accrue to an island owner. However, the court held that such ownership only includes those accretions adjacent to the riparian land and bounded by lines at right angles to the thread of the stream. Therefore, plaintiff could not claim the upstream accretions opposite defendant's shoreline. The court affirmed a judgment for defendant. The other riparian owner's suit rested on adverse possession. However, actual possession of the mainland was not adverse possession of the adjacent accretions. Therefore, the court reversed a judgment for the second mainland owner. (Liptak-Florida)  
W71-03491

**UNITED STATES V STEWART (LAND  
DESCRIBED AS BOUND BY THE WATER'S  
EDGE IS THAT LAND ABOVE THE MEAN  
HIGH WATER MARK).**

121 F2d 705-714 (9th Cir 1941).

Descriptors: \*California, \*Islands, \*Boundaries (Property), \*Boundary disputes, Public lands, Patents, Grants, Judicial decisions, Legal aspects, Navigable waters, Reclamation, Swamps, Overflow, Tidal waters, High water mark, Low water mark, Tides, Tidal effects, Watercourses (Legal), Real property, Marshes.

Plaintiff United States sought to quiet title in itself to a certain island. Defendant contended that the only land that belonged to plaintiff was what was commonly known as Mare island and not the marsh lands attaching thereto. Plaintiff contended that it held title to all the land described in its grant as being bound by the water's edge. The court ruled that the water's edge was the same as the shore. The shore is the land between the ordinary high and low water marks. Where a sea or bay is named as a boundary, the line of the ordinary high water mark is always intended in jurisdictions where the common law prevails. The land in dispute was above the high water mark at the time of the grant and at the time of its confirmation. The trial court's judgment for defendant was affirmed in part and reversed in part. (Price-Florida)  
W71-03524

**GUCKER V TOWN OF HUNTINGTON  
(DESTRUCTION OF RIPARIAN RIGHTS OF  
ACCESS BY RAISING LEVEL OF SAND BAR).**

268 NY 43, 196 NE 737-40 (1935).

Descriptors: \*New York, \*Sand bars, \*Riparian rights, \*Accretion (Legal aspects), Remedies, Land tenure, Real property, Navigable waters, Bays, Shallow water, Riparian land, Cities, Boundary disputes, Boundaries (Property), Ownership of beds, Legal aspects, Judicial decisions, Adjudication procedure.

Plaintiff owned upland situated on a navigable river. Defendant town owned a sand bar in the waters adjacent to plaintiff's property. Defendant authorized other persons to raise the level of the sand bar to a height above the normal high tide level. The sand bar had previously been sufficiently submerged to allow passage of boats of light draft at high tide. Plaintiff claimed title in the sand bar by accretion and asserted that defendant's actions, by preventing access to the navigable bay, derogated his riparian rights. Affirming plaintiff's riparian right of direct access to the bay, the Court of Appeals of New York observed that the lower court had failed to provide plaintiff a remedy, although it had recognized that his rights were destroyed. Since the action was equitable, the lower court should have provided a remedy. This was so even though the trial court had found title to the sand bar to be in defendant. The lower court's decision was reversed. (Hart-Florida)  
W71-03525

**INVENTORY INFORMATION ON PUBLIC  
LANDS, VOLUME II.**

Public Land Law Review Commission, Washington, D. C.

Available from NTIS as PB-194 198, \$3.00 in paper copy, \$0.95 in microfiche. Washington, D. C. July 1970. 127 p.

D  
Identifiers: Public land, Technical reports, Inventories, Classifications, Financing, Records management, Organizations, Surveys, Information systems, Problem solving.

The statistical data on resources and uses which are available for section 10 lands are shown in Volume 1 of this study. Volume 2 examines agency objectives, standards and methods for the compilation of such data and summarizes staff findings of their adequacy for purposes of the Commission's studies.  
W71-03528

**VILLAGE OF MILL NECK V TOWN OF  
OYSTER BAY (ALLOCATION OF WATER DIS-**

## Field 06—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

#### TRICT PROPERTY AMONG NEWLY INCORPORATED TOWNS.

140 Misc 164, 250 NYS 317-323 (Sup Ct 1931).

Descriptors: \*New York, \*Water districts, \*Public utilities, \*Cities, Local governments, Governments, Water supply, Real property, Land tenure, Public utility districts, Public lands, Public rights, Legal aspects, Judicial decisions, Assessments, Government finance, Legislation.

Plaintiff village brought action against defendant town to apportion and distribute the property of a water district. Plaintiff had been a part of the town and the water district and contended that upon incorporation it was entitled to a division of the water district's assets in proportion to the assessed value of plaintiff's property. The Supreme Court of New York noted that, although the statutes entitled plaintiff to an apportionment of the property, the legislature did not intend that the water district's property be sold and the proceeds divided among every new town or village. This would be impossible without destroying the water district. The court held that plaintiff was entitled to an apportioned interest in the water district's property. However, such interest should be neither divisible nor subject to partition and sale so long as the water district continued to function. (Liptak-Florida)  
W71-03540

#### LEGAL RESTRAINTS ON AGRICULTURAL POLLUTION, Virginia Polytechnic Inst., Blacksburg. Water Resources Research Center.

For primary bibliographic entry see Field 05G.  
W71-03552

#### SIEGEL V STATE (STATE LIABILITY FOR NEGLIGENCE IN IMPROVEMENT OF NAVIGATION).

138 Misc 474, 246 NYS 652-665 (Ct Cl NY 1930).

Descriptors: \*New York, \*Navigable waters, \*Stream erosion, \*Stream improvement, Damages, Eminent domain, Condemnation, Compensation, Legal aspects, Judicial decisions, Adjudication procedure, Canals, Streams, Non-navigable waters, Riparian rights, Riparian land, Erosion, Accelerated erosion, State governments, Bank erosion, Erosion control, Navigation.

Defendant state, for the purpose of improving a barge canal, lowered the bed of Fish Creek. Wood Creek, which flowed through plaintiff's property, emptied into Fish Creek. The lowering of Fish Creek caused Wood Creek to flow at greatly increased velocity, eroding plaintiff's land. Plaintiff sought damages for appropriation of his property. Defendant contended that it did not appropriate any of plaintiff's property or rights, but that plaintiff's losses were incidental to defendant's attempt to improve navigation. The Court of Claims of New York reversed a judgment for defendant. The acts of defendant, not being in an effort to improve the navigability of Wood Creek, but to improve the navigation in an entirely different channel, it could not escape responsibility for negligent injury to a riparian owner on Wood Creek. Negligence could be found in defendant's failure to erect structures capable of controlling the flow of Wood Creek. (Dye-Florida)  
W71-03566

#### LECTURES ON WATER MANAGEMENT. Dept. of Environmental Engineering Science. Johns Hopkins Univ., Baltimore, Md. For primary bibliographic entry see Field 06B. W71-03594

#### CANADA - UNITED STATES INTERNATIONAL WATER PROBLEMS, Manitoba Hydro, Winnipeg.

D. M. Stephens.

Lectures on Water Management, Water Management Seminars, Johns Hopkins University, April 5, 1965, p 264-281.

Descriptors: \*International joint commission, Boundaries (Property), \*United States.

Identifiers: \*Boundary Waters Treaty, St. Lawrence Seaway, Columbia Storage Development, Passamaquoddy Tidal Project, \*Canada.

The 400 miles of border between the United States and Canada includes countless numbers and varieties of bodies of water, ranging from meager streams to Lake Superior and the Columbia River. Since the establishment of the Border Treaty of 1909, the International Joint Commission has resolved such issues as insuring equitable effects from one country's diversion of rivers and overseeing a fair division of water resources and facilities which border both countries. The author deals at length with the instrumentation that the commission uses to carry out its work and praises its record of achievement. He stresses the need to adjust to the new problems of the future and mentions that the commission has already dealt with such joint concerns as pollution and maintenance of recreational facilities. (See also W71-03594) (Holmes-Rutgers)  
W71-03596

#### INDIA EYES THE OCEAN'S RESOURCES,

Science Service, Washington, D.C.

S. K. Ghaswala.

Science News, Vol 98, No 1, July 4, 1970, p 22.

Descriptors: \*Oceanography, Fish establishment, Fish farming, Trawling, Oil exploration, Government finance, Economics.

Identifiers: \*India, \*National Institute of Oceanography, Dr. N. K. Panikkar, Indian Ocean, Arabian Sea, Bay of Bengal, Fourth Five-Year Plan, Kerala, Marine Products Export Promotion Council, India Government's Oil and Natural Gas Commission, United Nations, The Deep Sea Fishing Station.

India's National Institute of Oceanography is aiding in the expansion of India's fishing industry by extensive exploration for new fishing waters and for deep sea water potentialities. The author points to the need for more and larger trawlers so that sufficiently mature fish can be caught in deeper waters further offshore. In addition to exploring for fish, the Indian government has begun to explore for oil in the Gulf of Cambay on India's west coast. It is expected that more than 4 million tons of crude oil will be obtained from offshore drilling by 1978-79. (Holmes-Trutgers)  
W71-03599

#### POLITICAL AND BUDGETARY CONSTRAINTS: SOME CHARACTERISTICS AND IMPLICATIONS,

Ministry of Aviation, London (England).

For primary bibliographic entry see Field 06C.  
W71-03620

#### WISCONSIN V MICHIGAN (NAVIGABLE WATER AS BOUNDARY BETWEEN STATES).

295 US 455, 55 S Ct 786-789 (1935).

Descriptors: \*Wisconsin, \*Michigan, \*Boundary disputes, \*Equitable apportionment, Boundaries (Property), Legal aspects, Water rights, Islands, Streams, Lakes, Great Lakes, Lake Michigan, Riparian rights, Bays, Federal jurisdiction, Judicial decisions, Channels, Bodies of water, Interstate.

The waters of Green Bay comprised a portion of the boundary between plaintiff Wisconsin and defendant Michigan. The enabling act creating the state of Michigan described the center of the 'most usual ship channel' of the Bay as the boundary line between plaintiff and defendant. A boundary dispute between the parties arose over the fact that two distinct ship channels existed, to either of

which the description might apply. The United States Supreme Court, in affirming the opinion of a special master, held that the waters of Green Bay should be divided between the states so as to give equality of opportunity in use of its waters. In reaching its decision the Court considered the principle that when a navigable stream is the boundary between states, the middle of the main channel, as distinguished from the geographical middle of the stream, limits jurisdiction of each state. This is so unless the boundary is otherwise fixed by agreement. The Court assumed that Congress intended in the Michigan enabling act to give the parties equality of right and opportunity for navigation and fishing. (Powell-Florida)  
W71-03626

#### ROSS V GRAFTON POWER CO (RIGHT TO DISCHARGE OF INDEBTEDNESS FOR FLOWAGE EASEMENTS).

1 F Supp 485-487 (D Vt 1932).

Descriptors: \*Easements, \*Debt, \*Contracts, \*Payment, Riparian land, Legal aspects, Judicial decisions, Land use, Rivers, Electric power industry, Right-of-way, Land tenure, Leases, Investment, Cost repayment.

Plaintiff holder of riparian flowage easements sought equitable discharge of indebtedness certificates issued to riparian owners for such easements. Under contract, plaintiff had transferred the flowage rights to defendant power company's assignor. The easements were granted in return for a promise by defendant to indemnify plaintiff against all claims by holders of indebtedness certificates. Plaintiff did not allege any breach of contractual duty by defendant, but contended that he was entitled to discharge of the indebtedness certificates by defendant, despite the promise of indemnification by defendant. The court held plaintiff's action premature. A riparian easement holder who under terms of contract is offered adequate indemnity is not entitled to discharge of indebtedness for such easements. Plaintiff's action for accounting and discharge was dismissed for failure to state a cause of action. (Earl-Florida)  
W71-03628

#### PROBLEMS IN ACHIEVING SOIL AND WATER CONSERVATION.

National Academy of Sciences, Washington, D.C.  
For primary bibliographic entry see Field 05G.  
W71-03634

#### WORLD RESOURCES AND TECHNOLOGY, London Univ. (England).

L. Dudley Stamp.

In: Readings in Resource Management and Conservation, Chicago, University of Chicago Press, 1965, p 97-103.

Descriptors: \*Natural resources, \*Technology, \*Conservation, Alluvial channels, Population, Economic aspects, Recreation, Water resources, Moisture, Fish, Statistics, Rivers, Erosion, Farming, Fertilizers, Irrigation, Drainage, Economic efficiency, Cultivation.

Identifiers: \*Zuyder Zee, \*Polar lands, \*World resources, Oceanic trench, Chemicalization.

This article discusses the problems faced by the world community in maintaining its economic well-being through the prudent use of the world resources. Technology is cited as a means that has been, and will continue to be, quite helpful in this endeavor. The role of water resources is especially important to economic maintenance and development. One example cited is the Dutch reclamation of the Zuyder Zee and the alluvial banks at the mouth of the Rhine. The U.S. depression of the 1930's coupled with successive bad seasons focused American attention on the problems of soil erosion, and the need for action similar, although not quite as drastic, as the Dutch. It is suggested that it may be economically feasible to retrieve

valuable material carried into American rivers through the erosion process. (See also W71-03631) (Murphy-Rutgers) W71-03640

**COASTAL PETROLEUM CO V SECRETARY OF THE ARMY (NON-NAVIGATIONAL GROUNDS FOR DENIAL OF PERMIT TO MINE IN NAVIGABLE LAKE BED).**

315 F Supp 845-850 (SD Fla 1970).

Descriptors: \*Rivers and Harbors Act, \*Lake beds, \*Mining, \*Permits, Leases, Florida, Lakes, Navigable waters, Navigation, Mineral industry, Excavation, Administrative agencies, State governments, Remedies, Damages, Compensation, Legal aspects, Judicial decisions, Water quality, Water supply, Water conservation, Water resources, Saline water intrusion, Ecology, Regulation.  
Identifiers: \*Lake Okeechobee.

Plaintiff mining company sued to compel defendant secretary of the army to issue a permit to mine limestone in Lake Okeechobee, a navigable lake. Plaintiff contended that it had a legal right to mine under leases from the state and that defendant could not deny a permit since there had been no finding that the mining would interfere with navigation. Defendant contended that it could deny the permit in view of the mining's detrimental effect on wildlife and the danger of saline intrusion into the lake, a major fresh water supply for the state. Defendant also argued that limestone was not within the terms of the mineral leases from the state. The court held that defendant could not deny a permit for other than navigational reasons and that the validity of the mining leases as to limestone had already been established by state court decisions. However, the court refused to order the issuance of the permit because of the potential harm to the public interest. Plaintiff's remedy was damages for its loss of profits. (Liptak-Florida)  
W71-03684

**TENNECO, INC V GREATER LAFOURCHE PORT COMM'N (LIABILITY FOR COST OF PIPELINE CHANGES BECAUSE OF CHANNEL IMPROVEMENT).**

427 F2d 1061-1066 (5th Cir 1970).

Descriptors: \*Pipelines, \*Permits, \*Channel improvement, \*Right-of-way, Navigable waters, Bayous, Louisiana, State governments, United States, Regulation, Public rights, Easements, Eminent domain, Condemnation, Legal aspects, Judicial decisions, Oil, Oil industry, Navigation.

Plaintiff oil company brought action against defendant port commission to recover the cost of lowering a pipeline crossing a navigable channel. Defendant contended that both plaintiff's state and federal permits required it to bear the cost of changes necessitated by channel improvement. Plaintiff contended that the permit requirements applied only to that part of the pipeline covered by the permit, that is, that part of the pipeline under navigable waters. Plaintiff argued that defendant was liable for the cost of changes in the pipeline on adjacent upland. Reversing judgment for defendant, the court held that conditions in the permits could only be construed as applicable within the actual pipeline right-of-way, not to portions of the pipeline outside of the right-of-way and on private property. (Liptak-Florida)  
W71-03705

**AN ECONOMIC EVALUATION OF CONNECTICUT WATER LAW: WATER RIGHTS, PUBLIC WATER SUPPLY AND POLLUTION CONTROL,**  
Connecticut Univ., Storrs. Inst. of Water Resources.  
For primary bibliographic entry see Field 06B.  
W71-03732

**KING V UNITED STATES (INVERSE CONDEMNATION BY FLOODING FROM BACKWATER).**

427 F2d 767-770 (Ct Cl 1970).

Descriptors: \*Dams, \*Backwater, \*Condemnation, \*Floods, Water injury, Flood damage, United States, Kansas, Federal government, Rivers, Navigable rivers, Damages, Compensation, Riparian land, Riparian waters, Riparian rights, Overflow, Legal aspects, Judicial decisions, Eminent domain, Condemnation value.

Plaintiff landowners brought action against defendant United States for inverse condemnation of their property, which was intermittently flooded by backwater from a dam. Plaintiffs contended that the flooding resulted in a taking of their property. Defendant contended that plaintiffs' property was subject to flooding before the erection of the dam and that some plaintiffs claimed damage to lands rented out to other plaintiffs as crop tenants. The court held that the construction of the downstream dam, subjecting property to increased flooding, constituted a taking of property under the fifth amendment. The court also noted that it was possible to separately compensate those owning different interests in the land and crops. Judgment was entered for plaintiffs. (Liptak-Florida)  
W71-03745

**BRYANT V PEPPE (TITLE TO SUBMERGED LAND REMAINS IN STATE AFTER EMERGENCE BY AVALSTION).**  
238 So 2d 836-839 (Fla 1970).

Descriptors: \*Florida, \*Ownership of beds, \*Avulsion, \*Land tenure, Boundaries (Property), Beds, Navigable waters, State governments, Gulf of Mexico, Taxes, Assessments, Boundary disputes, Riparian land, Riparian waters, Real property, Islands, Legal aspects, Judicial decisions, Public lands, Public rights.

Plaintiff landowners sued defendant state public land trustees to quiet title to land. The land had been submerged between two keys, but emerged as dry land as a result of avulsion during a hurricane. The state claimed the land as sovereignty land by reason of its originally submerged character. Plaintiffs contended that they held title by virtue of equitable estoppel because the land had been assessed as gulf-front property and plaintiffs had paid taxes thereon for many years. Reversing a judgment for plaintiffs, the court held that equitable estoppel was a proper remedy to bolster title already existing. However, estoppel could not be used to divest the state of its title. Submerged land does not lose its sovereign character when, by avulsion, it becomes dry land. (Liptak-Florida)  
W71-03774

**LANGEVIN V FLETCHER (BOUNDARY DISPUTE WHERE CONVEYANCE IS TO BANK OF BROOK IN RAVINE).**  
273 Mass 543, 174 NE 194-196 (1931).

Descriptors: \*Massachusetts, \*Boundary disputes, \*Streams, \*Banks, Beds, Boundaries (Property), Real property, Land tenure, Adjudication procedure, Legal aspects, Judicial decisions, Ravines, Gullies, High water mark, Ownership of beds, Land, Channels.

Plaintiff riparian landowner sought to register her land. Defendant contiguous landowner opposed her registration. Both tracts had formerly been owned by plaintiff, but plaintiff had conveyed defendant's tract to her brother. The conveyance was to the 'bank' of a brook which was in the bottom of a deep ravine with long sloping sides. Defendant contended that his boundary was the edge of the stream at the ravine's bottom, whereas plaintiff asserted that the boundary was the top of the ravine. Noting that a conveyance bounded by a stream bank normally excludes the streambed when the bank has a width apart from the bed, the Supreme

Judicial Court of Massachusetts observed that an unusual meaning attributed to 'bank' might be shown from the entire deed and the surrounding circumstances. The court held that the deed was ambiguous, permitting introduction of extrinsic evidence to show plaintiff's intent. On the introduction of such evidence, the court held that the conveyance was to the top of the ravine, although it had never been a 'bank' of the stream. (Hart-Florida)  
W71-03756

**A UNIFIED NATIONAL PROGRAM FOR MANAGING FLOOD LOSSES.**

Task Force on Federal Flood Control Policy, Washington, D.C.

Report by the Task Force on Federal Flood Control Policy, House Document No 465, transmitted in a communication from the President of the United States, Aug 1966. 47 p, 11 fig.

Descriptors: \*Flood control, \*Flood plains, \*Flood forecasting, \*Federal government, Flood damage, Flood plain insurance, Rivers, Floods, Planning, Costs, Cost sharing, Engineering structures, Levees, Reservoirs, Watersheds (Basins), Channels, Water policy, Projects, Project planning, State governments, Feasibility studies, Federal project policy, Administrative agencies, Flood plain zoning, Legislation.

Submitting its report on methods of reducing flood losses, the President's Task Force on Flood Control Policy stresses the need for a more unified national program. Basic proposals by the task force indicate a need: (1) to improve basic knowledge about flood hazards, (2) to coordinate and plan new developments on the flood plains, (3) to provide technical services to managers of flood plain property, (4) to move toward a practical national program for flood insurance, and (5) to adjust federal flood control policy to sound criteria and changing needs. Under these basic headings are delineated the roles of various federal agencies in collection and dissemination of flood information, flood forecasting, and assistance to states in flood plain planning. Cost-sharing requirements, flood project benefits and other monetary aspects of flood control programs also receive attention. The report describes the present condition of the nation's flood plains in terms of past federal investment in: (1) flood control, (2) past flood losses and estimated future losses, (3) effectiveness of flood control projects, and (4) benefits derived from them. Elements bearing on the problem of flood damages are also discussed. (Duss-Florida)  
W71-03773

**EXECUTIVE ORDER 11296 (EVALUATION OF FLOOD HAZARD IN FEDERAL ACTIVITIES).**  
Exec Order No 11296, Federal Register, Vol 31, No 155, Aug 11, 1966. 2 p.

Descriptors: \*Federal government, \*Floods, \*Flood plains, \*Administrative agencies, Flood damage, Flood control, Flood protection, Structures, Construction, Government finance, Regulation, Highways, Land, Administration, Federal budgets, Planning, Administrative decisions, United States.  
Identifiers: \*Executive orders.

Because of the existant uneconomic use of the nation's flood plains, the increasing potential for flood losses, the extensive federal involvement in construction of facilities in flood hazard areas, and the determining factor federal financing can play in land development, the President issued to various federal agencies Executive Order 11296. The President ordered that heads of executive agencies encourage a unified effort to prevent uneconomic uses of flood plains and, particularly, act to lessen the risk of flood losses in connection with federal lands and institutions. All agencies involved with construction of federal structures, government financing of structures, disposal of federal land,

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and land use planning were ordered to evaluate flood hazards in their respective spheres of operation. The heads of each agency may issue appropriate rules and regulations to accomplish the first objective of the order. Agencies to which requests for flood hazard information may be addressed are specified. In all requests for appropriations for federal structures, the agency involved shall transmit to the Bureau of the Budget its findings regarding evaluation of flood hazards in the proposed development. (Duss-Florida)  
W71-03778

#### BOUNDARY WATERS PROBLEMS OF CANADA AND THE UNITED STATES (RESOLUTION OF BOUNDARY DISPUTES BY THE INTERNATIONAL JOINT COMMISSION), L. M. Bloomfield, and Gerald F. Fitzgerald.

Boundary Waters Problems of Canada and the United States, Carswell Co, Ltd, Toronto, Canada (1958). 264 p, 1 map, 329 ref, 9 append.

Descriptors: \*United States, \*Treaties, \*International waters, \*International Joint Commission, International law, Water law, Federal government, Foreign waters, International commissions, Legal aspects, Judicial decisions, Governments, Administrative agencies.

Identifiers: \*Boundary waters.

In the Boundary Waters Treaty of 1909 between the United States and Canada, the International Joint Commission was formed and charged with judicial, investigative, administrative, and arbitral functions pertaining to boundary waters. This work relates: (1) the history of the Commission's formation, (2) purposes of the treaty, (3) the Commission's activities, and (4) the Commission's organization and rules of procedure. A detailed examination of the Commission's judicial function includes: (1) jurisdiction, (2) treaty rules governing judicial decision, (3) orders of approval, (4) compensation and indemnity, and (5) agreements between parties. The author concludes that: (1) the Commission has functioned extremely well, (2) the main prospective role will be investigation and recommendation, (3) the Commission has been reluctant to decide legal issues, and (4) regional and local requirements have been given careful consideration. Included in the work are summaries of the first 72 cases brought before the Commission. (Hart-Florida)  
W71-03781

#### MAINE LAW AFFECTING MARINE RESOURCES, VOLUME I: STATE GOVERNMENT ORGANIZATION: AGENCIES DEALING WITH MARINE RESOURCES.

Maine Univ., Portland. School of Law.

Available from NTIS as PB-189 467, \$3.00 in paper copy, \$0.95 in microfiche. University of Maine Law School, 1969. 156 p, 1 chart, 351 ref.

Descriptors: \*Maine, \*State governments, \*Administrative agencies, \*Administration, Governments, Legislation, Political aspects, Legal aspects, Institutions, Organizations, Regulation, Coordination, Administrative decisions, Water law, Economics, Leadership, Planning, Water resources development, Water resources, Resources, Natural resources, Water policy, Conservation, Water conservation.  
Identifiers: \*Marine resources.

An important aspect of Maine law affecting marine resources is the structure of the administrative machinery responsible for ocean related activity. This survey of Maine agencies seeks to answer several questions: (1) Could better management of Maine's ocean potential be achieved by realignment or consolidation of existing entities. (2) What should be the configuration of the new administrative structure. (3) What are reasons for the charges and obstacles to be overcome. The discussion is divided into four parts. Part I summarizes the general administrative structure of water resources agen-

cies and gives general suggestions for consolidation and improvement. Part II describes those agencies which, although not exclusively marine agencies, affect marine resources, including each agency's interrelationship with other agencies in the field. Part III suggests consolidation of some functions and describes political factors and attitudes which have impeded reorganization in the past. Part IV presents those proposals of previous reports, governors, and other state officials which have received inadequate notice and implementation. (See also W71-03784 thru W71-03786) (Dye-Florida)  
W71-03783

#### MAINE LAW AFFECTING MARINE RESOURCES, VOLUME II: STATE, PUBLIC, AND PRIVATE RIGHTS, PRIVILEGES, AND POWERS.

Maine Univ., Portland. School of Law.

Available from NTIS as PB-189 468, \$3.00 in paper copy, \$0.95 in microfiche. University of Maine School of Law, p 157-417, 1970. 6 charts, 746 ref, 1 append.

Descriptors: \*Maine, \*Public rights, \*Riparian rights, \*Water law, Legal aspects, Relative rights, Natural resources, Coasts, Harbors, Oceans, Administrative agencies, Planning, Legislation, Water resources development, Marine fisheries, Fishing, State governments, Federal government, Water resources, Conservation, Boundaries (Property), Accretion (Legal aspects), Avulsion, Judicial decisions.  
Identifiers: \*Marine resources, Private rights.

Volume II of a four-volume report on Maine law affecting marine resources, this work examines Maine water resources law and its social and economic impact on the exploitation of the state's marine-related resources. Chapter I appeared in Volume I and dealt with state government structure. Chapter two discusses international, federal, and state law regarding marine boundaries, including: (1) the extent of state territorial waters; (2) local governmental boundaries; (3) private and public lands at the seashore; (4) construction of deeds of conveyance between adjacent riparian owners; and (5) the effects of accretion, avulsion, and reliction on boundaries. Chapter three deals with relative public and private rights in tidal lands and water, with emphasis on the colonial ordinances from which such law is derived. Classification of waters as navigable or non-navigable is examined, along with the state's right to regulate navigation. Chapter four discusses the legal structure within which the state may exploit or dispose of Maine's water resources. Constitutional limitations on the state are explored, concluding with the opinion that few such strictures exist. An appendix lists cases referred to in Volumes I and II. (See also W71-03783) (Dye-Florida)  
W71-03784

#### MAINE LAW AFFECTING MARINE RESOURCES, VOLUME III: REGULATION OF THE COAST: LAND AND WATER USES.

Maine Univ., Portland. School of Law.

Available from NTIS as PB-192 023, \$3.00 in paper copy, \$0.95 in microfiche. University of Maine Law School, p 419-627, 1970. 1 map, 2 illus, 2 chart, 497 ref, 4 append.

Descriptors: \*Maine, \*Land use, \*Regulation, \*Coasts, Land management, Shores, Land resources, Natural resources, Legal aspects, Legislation, Land development, Recreation, Zoning, State governments, Local governments, Institutions, Planning, Water resources development, Water resources, Water pollution, Water law, Water pollution control.  
Identifiers: \*Marine resources.

Volume III of a four-volume report on Maine law affecting marine resources, this volume deals with coastal regulation relating to land and water uses.

In Chapter five the extent and effects of pollution in Maine's coastal waters are discussed, along with the common law and statutes bearing on water pollution in Maine. Chapter six considers Maine law regulating coastal land and the adjacent environment. Laws are discussed as to their necessity and appropriateness, with emphasis on regulation of recreational usage. Municipal, regional, and state planning to maintain and improve the quality of coastal land usage is also emphasized. Chapter seven attempts to apply concepts of land use control to water areas below the low-water mark, as to which a comprehensive plan for usage regulation is otherwise lacking. Chapter eight examines the effect of state taxation on marine resource usage. Chapter nine discusses state and federal machinery dealing with problems of coastal erosion. Chapter ten reviews water-related legislation enacted by a 1970 special session of the Maine legislature, reproducing in full acts: (1) preventing the dumping of out of state waste in Maine waters; (2) regulating selection of industrial sites; and (3) preventing petroleum pollution of coastal waters. (See also W71-03783) (Dye-Florida)  
W71-03785

#### MAINE LAW AFFECTING MARINE RESOURCES, VOLUME IV: RESOURCES FROM THE SEA AND FEDERAL LIMITATIONS ON STATE CONTROL.

Maine Univ., Portland. School of Law.

Available from NTIS as PB-194 131, \$3.00 in paper copy, \$0.95 in microfiche. University of Main Law School, p 629-903, 1970. 2 tab, 14 chart, 582 ref, 2 append.

Descriptors: \*Maine, \*Water resources development, \*Federal jurisdiction, \*State jurisdiction, Natural resources, Resources, Legal aspects, Legislation, Governments, State governments, Federal government, Regulation, Administration, Water resources, Resource development, Fishing, Commercial fishing, Fisheries, Fish harvest, Fish management, Ecology, Fish conservation, Mining, Exploitation, Mineral industry.  
Identifiers: \*Marine resources.

Volume IV of a four volume report on Maine law affecting marine resources, this volume is concerned with international, federal, and state regulation of the extraction of resources from the sea. Chapter eleven deals with treaties and laws affecting Maine fisheries. The ends sought by fishing laws are discussed, with an attempted evaluation of their effectiveness. Included are taxing provisions, prohibitions against foreign fishermen, anti-trust regulations, and the economic and ecological considerations influencing fishing regulation. Chapter twelve deals with legislation regulating the extraction and cultivation of renewable marine resources, mainly shellfish. The conflict between commercial fishing for such resources and their conservation for public use is emphasized. Chapter thirteen discusses restrictions on the utilization of marine resources as food, emphasizing health and quality-control measures. Consideration is given to regulation under the Federal Food and Drug Act and to efforts to promote and market Maine's marine products. Chapter fourteen discusses regulations and state agencies governing extraction of minerals from Maine's waters. Chapter fifteen deals with federal imitations on state control of marine resources--both under the constitution and under federal legislation. (See also W71-03783) (Dye-Florida)  
W71-03786

#### WATERSHED PROJECTS.

Committee on Agriculture (U. S. House). Subcommittee on Conservation and Credit.

Hearings, 91st Cong, 1st Sess, July 8, 9, Aug 4, Sept 23, 25, Oct 15, 20, 1969. 213 p.

Descriptors: \*Watersheds (Basins), \*Water resources development, \*Flood protection,

\*Legislation, Watershed management, River basin development, Multiple-purpose projects, Project benefits, Project purposes, Project feasibility, Project planning, Programs, United States, Governments, Flood control, Social aspects, Water policy, Legal aspects.

Hearings before the Subcommittee on Conservation and Credit of the Committee on Agriculture were held to hear testimony concerning various watershed protection and flood prevention projects. The watershed projects involved were located in Arizona, Arkansas, California, Florida, Georgia, Iowa, Indiana, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Minnesota, Nebraska, Nevada, New Mexico, North Carolina, Ohio, Tennessee, Utah, Virginia, West Virginia, and Wyoming. The public officials and private parties testifying before the Subcommittee geographically described the respective watersheds and discussed: (1) flood and water management problems, (2) purposes and principal measures of watershed work plans and (3) estimated costs of watershed programs. The Subcommittee was primarily concerned with the agricultural aspects of the various watershed projects. (Powell-Florida) W71-03787

#### AUTHORITY TO THE SECRETARY OF AGRICULTURE TO MODIFY CERTAIN LEASES IN RE: RECREATIONAL FACILITIES IN RESERVOIR AREAS.

Committee on Agriculture (U.S. House). Subcommittee on Forests.

Hearings, Forest Lands, 87th Congress, 1st Sess., Aug 7, 8 and 14, 1961, p 4-5.

Descriptors: \*Legislation, \*Leases, \*Recreation facilities, \*Reservoirs, Forests, United States, Forest management, Construction, Maintenance, Administrative agencies, Operation, Water resources development, Jurisdiction, Legal aspects, Rental, Payment, Adjusted prices, Public benefits.

Hearings before the Subcommittee on Forests of the House Committee on Agriculture were held for the purpose of considering H.R. 4934 to authorize the Secretary of Agriculture to modify certain leases entered into for the provision of recreation facilities in reservoir areas. The bill related to leases entered into by the Forest Service before November 1, 1956, providing for the construction, maintenance, and operation of commercial recreational facilities at water resource development projects under the jurisdiction of the Secretary of Agriculture. The bill would authorize the Chief of the Forest Service, under the supervision of the Secretary of Agriculture, to amend such concessionaire leases to permit the adjustment of rental rates or other consideration payable to the United States under such lease. (Finman-Florida) W71-03788

#### ESTABLISH THE OZARK SCENIC RIVERWAYS, CLARK NATIONAL FOREST, STATE OF MISSOURI.

Committee on Agriculture (U. S. House). Subcommittee on Forests.

Hearings, Forest Lands, 87th Congress, 1st Sess., Aug 7, 8, and 14, 1961, p 6-130.

Descriptors: \*Legislation, \*National forests, \*Missouri, \*National recreation areas, Conservation, Land use, Recreation, Scenery, Natural resources, River flow, Scenic easements, Agriculture, Legal aspects, Forest management, Land resources, Parks, Project purposes, Water resources development, Boundaries, Land, United States.

Hearings on H.R. 6289 to establish the Ozark Scenic Riverways in the Clark National Forest in the state of Missouri were held before the Subcommittee on Forests of the House Committee on Agriculture. The general purpose of the bill was to conserve and develop for the use and enjoyment of

the people of the United States the unusual recreational, scenic, and other natural and physical values along the Current and Eleven Point Rivers in the state of Missouri, including their preservation as free-flowing streams. The bill would obtain this objective by establishing the Ozark Scenic Riverways, to be administered by the Secretary of Agriculture as part of the Clark National Forest. The riverways would be generally comprised of relatively narrow strips of land along the Current and Eleven Point Rivers. Under the bill, the exterior boundaries of the Clark National Forest would be modified to include those portions of the designated riverways area lying outside the Forest's existing boundaries. Within the riverways, the Secretary of Agriculture would be authorized to acquire needed lands and interests in land, including scenic or conservation easements. (Finman-Florida) W71-03789

#### STATUS OF PENDING WATERSHED PROJECTS.

Committee on Agriculture (U. S. House).

Hearing, 90th Cong, 2d Sess, June 19, 1968, p 3-22.

Descriptors: \*Watershed Protect. and Flood Prev. Act, \*United States, \*Water policy, \*Multiple-purpose projects, Water resources development, Watershed management, Legislation, Legal aspects, Social aspects, Project benefits, Project planning, Project feasibility, Governments, Programs, Financing, Financial feasibility. Identifiers: \*Constitutionality.

A hearing before the House Committee on Agriculture was held to determine the status of pending watershed projects. Testimony was offered by the Deputy Director of the Bureau of the Budget, and the Assistant Secretary of Agriculture, with regards to pending programs authorized under the Watershed Protection and Flood Prevention Act. Testimony indicated that authorized watershed projects have been limited by: (1) inadequate financial appropriations, (2) President Johnson's decision not to seek a second term, and (3) President Johnson's attack on the constitutionality of the Watershed Protection and Flood Prevention Act. The Act provided that final approval for projects costing the federal government over \$250,000 was vested in the House and Senate Agriculture Committees. The President contended that this provision endeavored to empower the legislative branch, or part of it, to participate in the execution of laws, a function vested by the Constitution in the executive branch. A list of pending watershed projects is set forth. (Powell-Florida) W71-03790

#### WATERSHED PROJECTS.

Committee on Agriculture (U. S. House).

Hearings on Miscellaneous Subjects, 87th Cong, 1st Sess, Feb 15 and 16, 1961, p 3-87.

Descriptors: \*Legislation, \*Multiple-purpose projects, \*Watersheds (Basins), \*Water resources development, Flood protection, Project benefits, Project purposes, Project feasibility, Project planning, United States, Flood control, Legal aspects, Social aspects, Recreation, Water policy, Watershed management, Water utilization, River basin, Development, Cost sharing, Cost-benefit ratio, Financing, Costs, Federal government.

Hearings before the Committee on Agriculture were held to hear testimony advocating the approval of several watershed projects. The watershed projects involved were: Fishing Creek, South Carolina; Leatherwood Creek, Virginia; Marsh Creek, Kentucky; Tortugas Arroyo, New Mexico; Upper Josephine-Jackson, Florida; and Waianae Iki, Hawaii. Testimony was offered in favor of the respective projects by various public officials and private individuals, who discussed the economic, social and legal aspects of such

watershed projects. The Committee hearing explored the financial aspects of watershed protection and flood prevention programs, including cost sharing, valuation of acreage, acquisition of rights-of-way, and construction, operation and maintenance costs. The Committee also investigated the estimated cost of the watershed projects for each acre benefited. (Powell-Florida) W71-03791

#### LAW AND THE ENVIRONMENT.

Edited by Baldwin, Malcolm and Page, James K, Jr. New York, Walker and Co, 1970. 432 p, 738 ref.

Descriptors: \*Legal aspects, \*Water pollution, \*Water law, \*Environment, Ecology, Judicial decisions, Federal government, United States, Administrative agencies, Environmental effects, Balance of nature, Environmental effects, Legislation, Wildlife, Remedies, Air environment, Aquatic environment, Adjudication procedure.

The main subdivisions of this book on environmental law include: (1) Problems of Litigation, (2) Needed Developments in the Laws, and (3) Opportunities and Mechanisms to Meet the Needs. The first subdivision discusses the Santa Barbara Oil Spill history, its current status, and future predictions. It also examines the use of expert witnesses in environmental litigation. In the second subdivision the following topics are discussed by various authors: (1) burden of proof, (2) standing to sue, (3) the constitutional right to a decent environment, (4) the trust doctrine, and (5) the governmental role in environmental litigation. The third subdivision is divided into three topics: (1) the attorney's role in environmental litigation, (2) law college programs in the environmental field, and (3) trends in developing the environmental curriculum. Each section is followed by a panel discussion of the topic among the various authors involved. (See also W71-03793 thru W71-03798) (Hart-Florida) W71-03792

#### THE ROLE OF GOVERNMENT IN ENVIRONMENTAL CONFLICT,

Harold P. Green.

In: Law and the Environment, New York, Walker and Co 1970, p 235-247.

Descriptors: \*Federal government, \*Environmental effects, \*Administrative agencies, \*Legislation, Legal aspects, Public rights, Environment, Remedies, State governments, Social aspects, Administrative decisions, Pollution abatement, Ecology, Costs, Cost analysis, Balance of nature, Regulation, Administration. Identifiers: \*Ecological impact.

In this response to what the role of government should be in environmental conflict and how this role can be effectively played, it is suggested that private litigation cannot successfully defend the environment; hence, the government must intervene. The author suggests that government action may take three forms: (1) amicus curiae or intervenor; (2) legislation establishing environmental standards and prohibiting environmentally detrimental activities; and (3) regulatory legislation administered by an agency charged with establishing and enforcing environmental standards. Since each role requires legislation, the difficulty of inducing legislative action is examined. Determining that the fundamental problem in inducing legislation is the paucity of information available on the costs, risks, and adverse consequences of technological advancement, the author concludes that an ombudsman-type administrative agency should be established as an arm of Congress. The agency would be charged with the sole function of investigating, publicizing, and pressing upon Congress, the public, and the administrative agencies the potential adverse consequences involved in activities affecting the environment. (See also W71-03792) (Hart-Florida) W71-03793

## Field 06—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

#### OUTLINE OF FEDERAL ENVIRONMENTAL LAW FOR THE PRACTICING LAWYER,

James Watt Moorman.

In: Law and the Environment, New York, Walker and Co 1970, p 182-234.

Descriptors: \*Water pollution, \*Legal aspects, \*Environment, \*Remedies, Water utilization, Federal government, Water pollution sources, Water pollution effects, Ecology, Balance of nature, Environmental effects, Highway effects, Wildlife, Judicial decisions, Air environment, Aquatic environment, Estuarine environment, Deserts, Legislation, United States, Administrative agencies, Administrative decisions.

The author's outline of federal environmental law for the practicing lawyer is divided into two major areas—procedural and substantive environmental matters. In the procedural portion, jurisdiction (with emphasis upon standing), discovery, and other matters such as burden of proof and evidence are examined. The substantive portion is subdivided into three parts: (1) pollution, (2) land and water use, and (3) the public domain. Under 'pollution', the author discusses: (1) water pollution, with emphasis upon the effect of federal legislation in the area; (2) air pollution; (3) pesticides; and (4) noise pollution. Under 'land and water use', the various means of combating pollution of rivers, estuaries, and coastal waters are examined with respect to federal control and legislation. The means of combatting strip mining, highway routing, and fish and wildlife destruction are also discussed. In the subsection entitled 'the public domain', the author examines federal lands and parks, Alaska, the Outer Continental Shelf, and the Bureau of Land Management. (See also W71-03792) (Hart-Florida)

W71-03794

#### STANDING TO SUE IN CONSERVATION SUITS,

Louis L. Jaffe.

In: Law and the Environment, New York, Walker and Co 1970, p 123-133.

Descriptors: \*Legal aspects, \*Judicial decisions, \*Public rights, \*Administrative decisions, \*Environment, Administrative agencies, Natural resources, Decision making, Federal government, Legislation, Water resources development, Remedies, Conservation.

Identifiers: \*Standing to sue, Constitutional aspects.

The question considered by this chapter is: Who can initiate or participate in proceedings to preserve or improve environmental amenities. For this purpose, environmental action suits are categorized as either nuisance or non-nuisance actions. A private citizen cannot sue to enjoin a public nuisance without showing a particular injury; therefore, the public's right to abate a nuisance is normally enforced by public authorities. Because the public is often under-represented in administrative decisions, the public might seek judicial review of the decision. However, participation is severely inhibited by the constitutional case-or-controversy concept. Court decisions are analyzed, holding variously: (1) that a federal taxpayer has standing to contest federal expenditures in aid of religious activity; (2) that a conservation association is within the zone of interests protected by legislation requiring the FPC to consider the environmental impact of a power plant, and therefore has standing; (3) that television listeners are entitled to participate in both a hearing and review on the permit renewal of a TV station; and (4) that a party injured in fact and arguably within the zone of protected interests has standing to seek review of administrative action. The author concludes these decisions establish a general trend to liberalize the standing concept. (See also W71-03792) (Hart-Florida)

W71-03795

#### THE RIGHT TO A DECENT ENVIRONMENT: PROGRESS ALONG A CONSTITUTIONAL AVENUE,

E. F. Roberts.

In: Law and the Environment, New York, Walker and Co 1970, p 134-165.

Descriptors: \*Environment, \*Legal aspects, \*Judicial decisions, \*Public rights, Pollution abatement, Air pollution, Soil contamination, Water pollution, Thermal pollution, Legislation, Federal government, State governments, Community development, Environmental effects, Zoning, Eminent domain, Condemnation, Cities, Industries, Land use, Social aspects, Remedies, Ecology, Real property.

Identifiers: \*Constitutional aspects.

Speculating upon whether a right to a decent environment can be found within the Bill of Rights of the United States Constitution, this chapter primarily analogizes to the development of the right to privacy. Since the right to a decent environment cannot be expressly found, the author posits that it must be within a penumbra of one of the other amendments, or impliedly found in the ninth amendment. The use of the zoning power to maintain a decent environment is discussed in some detail. Also, the use of the eminent domain power in conjunction with the concept of the 'new property' is analyzed as a means of improving our environment. Rejecting both the zoning power and property law changes as inadequate to satisfy the public's demand for a halt to environmental destruction, the author concludes that a Supreme Court decision styled after *Griswold v Connecticut*, 381 US 479 (1965), is a necessary predicate to securing an improved environment. Moreover, the author recommends prospective application, leaving to legislators the task of correcting existing violations of the right to a decent environment. (See also W71-03792) (Hart-Florida)

W71-03796

#### LAW IN ACTION: THE TRUST DOCTRINE,

Edward Berlin, Anthony Z. Roisman, and Gladys Kessler.

In: Law and the Environment, New York, Walker and Co, 1970, p 166-181.

Descriptors: \*Reservation doctrine, \*Environment, \*Land use, \*Public rights, Legal aspects, Judicial decisions, Pollution abatement, Real property, Land tenure, Air pollution, Soil contamination, Water pollution, Thermal pollution, Legislation, Federal government, Remedies, State governments, Community development, Environmental effects, Administrative agencies, Administrative decisions, Social aspects, Ecology.

Identifiers: \*Constitutional aspects, \*Trust doctrine.

Speculating on application of the trust doctrine to improve the environment and to prevent further deterioration, property is categorized into three types: (1) property owned by the government, (2) property privately owned and used consistently with public interest; and (3) property privately owned but used inconsistently with public interest. As to government-owned property, the author suggests that mandamus and similar remedies may be used to prevent use inconsistent with the public interest; he also suggests that the fifth amendment impliedly requires that government property be used only in the public interest. For property in the second category, it must be established that the trust has been in existence from the beginning of our constitutional government and that all property transfers have an implicit condition that it will be used in the public interest. Two alternatives are suggested for establishing public interest in property in category three: (1) a condemnation action to preserve the property for public benefit; and (2) a mandamus action, joining the landowner, to require condemnation for the public. Although admitting that the expanded concepts of the trust doctrine are radical, the author concludes that such expansion presents a viable possibility for advance-

ment in the environmental area. (See also W71-03792) (Hart-Florida)

W71-03797

#### THE SANTA BARBARA OIL SPILL,

Malcolm F. Baldwin.

In: Law and the Environment, New York, Walker and Co 1970, p 5-47. 142 ref.

Descriptors: \*Oil industry, \*Administrative agencies, \*Federal government, \*Water pollution control, Water pollution sources, Water pollution effects, Oil, Water pollution, Pollutants, Environmental sanitation, Water pollution treatment, Administrative decisions, State governments, United States, Leases, Legislation, Rivers and Harbors Act, Submerged Lands Act, Oil fields, Natural gas, Exploitation, Legal aspects.

Identifiers: \*Santa Barbara Oil Spill, Water Quality Improvement Act.

The Santa Barbara Oil Spill is a lesson to be remembered. Although the spill was relatively minor, the effects were severe. Oil leasing began in the channel in 1965, following settlement of a jurisdictional dispute. The leases were subject to counter pressures by the Budget Bureau and oil companies vis-a-vis the public. The varied federal statutes, procedures, and agencies failed to prevent the spill. A post-mortem reveals that some requirements were meticulously followed while others were observed only in form. After the spill, the Department of the Interior established new regulations for drilling and exploration, and began to require leasing companies to submit proprietary information to the Department. The President's panel recommending renewed pumping to stop leakage was severely criticized. Congress responded to the spill by enacting the Water Quality Improvement Act, providing strict liability for oil spills up to \$8 million. However, the act does not affect drilling liability beyond the three-mile limit. The constitutionality of the Act has been questioned, and several companies have asserted that it breaches the leases. Other action for damages from the spill, and injunctions to prevent future drilling, have been filed. (See also W71-03792) (Hart-Florida)

W71-03798

#### ILLINOIS LAWS RELATING TO WATERWAYS, 1969.

Illinois State Dept. of Public Works and Buildings, Springfield.

Springfield, 1970. 246 p.

Descriptors: \*Legislation, \*Inland waterways, \*Water law, \*Illinois, State governments, Streams, Lakes, Navigable waters, Non-navigable waters, Bridges, Boats, Canals, Administrative agencies, Flooding, Flood control, Navigation, Watersheds (Basins), Watershed management, Water conservation, Cities, Parks, Water pollution, Legal aspects, Federal government, Rivers.

Identifiers: Constitutions.

Consolidated into this single volume are the: (1) Illinois statutes pertaining to rivers, lakes, and streams; and (2) Illinois statutes relating to the authority, duties, and jurisdiction of the Department of Public Works and Buildings and its Division of Waterways. Pertinent sections of the Illinois constitution preface this work. Additionally, federal legislation has been furnished where it interrelates with included state legislation. Supplementing extensive special legislation pertaining to specific rivers or flood control districts are laws of general applicability. Some titles of acts in this latter category are: bridges; pure water board; boat registration and safety; civil administration; commissions; counties; criminal laws; drainage; flood control; municipal code; nuisances; pollution; refuse from outside the state; rivers, lakes and streams; sanitary districts; watershed protection and flood prevention; water terminals; water authorities; and waterways. (See also W71-03800) (Hart-Florida)

W71-03799

## WATER RESOURCES PLANNING—Field 06

### Water Law and Institutions—Group 6E

#### ILLINOIS LAWS RELATING TO WATERWAYS, 1967.

Illinois State Div. of Waterways, Springfield.

Springfield, 1968. 232 p.

Descriptors: \*Illinois, \*Legislation, \*State government, \*Administrative agencies, Boats, Inland waterways, Dams, Drainage districts, Flood protection, Harbors, Port authorities, Reservoir operation, Water resources development, Submerged Lands Act, Water resources, Watershed management, Water pollution control, Legal aspects, Administration, Flood control, Interstate compacts, Buildings, Beds under water.  
Identifiers: Constitutions.

Presented in this publication is a compilation of selected Illinois statutory and constitutional material dealing with rivers, lakes, streams, and other water bodies. Statutes defining the duties, authority, and jurisdiction of the Illinois Department of Public Works and Buildings, and its Division of Waterways are provided, along with sections of the: Illinois Constitution, Illinois Revised statutes, Illinois Civil Administrative Code, Illinois Municipal Code, Illinois Criminal Code, and certain interstate compacts. The compilation encompasses such areas as: boat registration and safety, bridges, canals, dams, drainage and flood control districts, harbors, port districts, pure water boards, reservoirs, resource development boards, and sanitary districts. Other statutory topics include: submerged lands, watersheds, water pollution, water resources, water terminals, and surface water protection. Only selected sections of the pertinent statutes are provided, but references to the complete statutory provisions are included. (See also W71-03799) (Earl-Florida)  
W71-03800

#### WATER QUALITY STANDARDS.

Virginia State Water Control Board, Richmond.

July 1970. 59 p.

Descriptors: \*Virginia, \*Standards, \*Water quality control, \*Water quality, Legislation, Municipal water, Domestic water, Legal aspects, Social aspects, Public health, Recreation, Potable water, Recreation, Water treatment, Water pollution control, Municipal wastes, Sewage, Water resources.

Virginia Water Quality Standards are established by the Virginia State Water Control Board. The standards first set forth include those rules with general state-wide application, including standards established for the protection of public or municipal water supplies and standards which apply at raw water intake points. Next set forth are the rules with specific application based on climate, geographical area, or uses. The primary classifications of waters within the State are enumerated. Virginia water quality standards apply to fourteen basin and section descriptions, including: (1) Big Sandy River Basin, (2) Clinch River Basin, (3) Holston River Basin, (4) New River Basin, (5) Roanoke River Basin, (6) Chowan River Basin, (7) Shenandoah River Basin, (8) Rappahannock River Basin, (9) York River Basin, (10) James River Basin, (11) Chesapeake Bay and Atlantic Ocean, (12) Yadkin River Basin, (13) Albemarle Sound, and (14) Potomac River Basin. A key to special standards is provided. (Powell-Florida)  
W71-03801

#### OUR WATERS AND WETLANDS: HOW THE CORPS OF ENGINEERS CAN HELP PREVENT THEIR DESTRUCTION AND POLLUTION.

House Comm on Gov't Operations, Committee on Government Operations (U. S. House).

91st Cong, 2d Sess, HR Rep No 91-917. 18 p, 30 ref.

Descriptors: \*Federal government, \*Administrative agencies, \*Administration, \*Permits, Control, Legislation, Regulation, Governments, United

States, Navigation, Navigable waters, Water pollution, Water pollution sources, Conservation, Institutions, Riparian rights, Coastal engineering, Coastal structures, Rivers and Harbors Act, Transportation, Industries, Wastes, Waste disposal.  
Identifiers: \*Corps of Engineers.

By the House Committee on Government Operations, this report deals with measures which can be taken by the Army Corps of Engineers to alleviate the unfavorable ecological impact of private construction in or about navigable waters. Emphasis is placed on the Corps' procedures for reviewing and approving applications for construction. The committee recommends that the Corps, rather than basing approval wholly on the public interests to be served in the areas of navigation and commerce, give more weight than in the past to the possible ecological effects of the private activity. It is recommended that harbor lines established by the Corps be regarded as mere guidelines instead of absolute limits within which construction would be permitted without application. The Committee recommends that the burden should be on the applicant to prove that proposed construction would not be damaging to the ecology. Furthermore, the Corps should vigorously enforce the Refuse Act of 1899, prohibiting the dumping of foreign substances into navigable waters. (Dye-Florida)  
W71-03802

#### THE LAW OF INTERNATIONAL WATERWAYS,

R. R. Baxter.

The Law of International Waterways, Harvard Univ Press, Cambridge, Mass, 1964. 371 p, 2 tab, 1,118 ref, append.

Descriptors: \*International waters, \*Foreign waters, \*Canals, \*International law, Channels, St Lawrence Seaway, Panama Canal, Canal zone, Navigation, Regime, Water conveyance, Administration, Political aspects, Governments, Legal aspects, Judicial decisions, United States, International commissions, Legal aspects.  
Identifiers: \*International waterways, Interoceanic canals.

Those rivers, canals, and straits used to a substantial extent by commercial shipping or warships belonging to nations other than the riparian nation are international waterways. Discussing the international law relating to such waterways, major divisions of this book include: (1) operating agencies for international waterways, (2) passage of ships in peacetime, (3) passage of ships in wartime, (4) legal controls in the fiscal sphere, (5) technical problems of administration of international waterways, and (6) international administration of international canals. Five means of operating an international waterway are discussed: (1) administration by a private company (Suez Canal); (2) operation of an interoceanic canal by a foreign sovereign (Panama Canal); (3) operation of interoceanic canals by a territorial sovereign (Kiel and Suez Canals); (4) international cooperation (St Lawrence Seaway); and (5) international administration through international commissions. In an appendix, articles on the navigation of international canals are proposed as a model codification of existing customary law of international waterways. Emphasis is placed upon interoceanic canals. (Hart-Florida)  
W71-03803

#### NATURAL RESOURCES IN THE GOVERNMENTAL PROCESS A BIBLIOGRAPHY SELECTED AND ANNOTATED,

Arizona Univ., Tucson. Inst. of Government Research.

David F. Paulsen.

Tucson, University of Arizona Press, 1970. 99 p.

Descriptors: \*Bibliographies, \*Publications, \*Reviews, \*Natural resources, Economics, Forests, Water resources, Water resources development, River basins, Federal government, Grants,

Research and development, Water pollution, Decision making, Social aspects, Flood control, Reclamation, Resources development, Resources, Conservation, Governments, Fishing, State governments, Water conservation, Water policy.

A selected and annotated bibliography of the literature relating to governmental action in the field of natural resources, this book summarizes the literature, assesses trends, and evaluates the potential for further development in the area. Chapter two catalogues literature dealing with social theory and policy formation in the natural resources area. Chapter three examines basic natural resources literature including: fishing, minerals, natural resources of the ocean, and soil conservation. Chapter four emphasizes studies concerned with the governmental development of specific river basins. Chapter five catalogues works concerning: (1) water policy-formation processes; (2) reclamation, dams, and flood control; (3) water systems of state and local government; and (4) water pollution. References are listed alphabetically under each topic, and an index to the authors of the catalogued work follows the text. (Barnett-Florida)  
W71-03804

#### A SURVEY OF NEW HAMPSHIRE WATER LAW,

New Hampshire Univ., Durham. Water Resources Research Center.

Alexander J. Kalinski, and Robert H. Forste.

Available from NTIS as PB-197 122, \$3.00 in paper copy, \$0.95 in microfiche. WRRRC Bulletin 3, July 1970. 42 p, 46 ref. OWRR Project A-011-NH (4).

Descriptors: \*New Hampshire, \*Riparian rights, \*Judicial decisions, \*Water law, Legal aspects, Riparian land, Usufructuary right, Reasonable use, Remedies, Riparian waters, Alteration of flow, Competing uses, Natural use, Obstruction to flow, Surface waters, Drainage water, Repulsion (Legal aspects), Riddance (Legal aspects), Surface runoff, Groundwater, Percolating water, Reservation doctrine, Eminent domain, Condemnation, Compensation.

The two objectives of this survey are to describe the development of the common law riparian doctrine of New Hampshire and to examine water resources actions of recent years. Six aspects of the New Hampshire riparian doctrine are discussed: (1) the general extent of the riparian right, (2) the riparian owner, (3) riparian land, (4) doctrinal development, (5) surface waters, and (6) groundwaters. Various New Hampshire supreme court decisions bearing on these aspects are analyzed in depth. The recent water resources actions discussed include: (1) nuisance abatement; (2) the public trust doctrine; (3) private exercise of eminent domain; and (4) mandamus. New Hampshire supreme court decisions pertaining to these actions are examined. (Hart-Florida)  
W71-03805

#### WATER FOR ILLINOIS - A PLAN FOR ACTION.

Illinois State Technical Advisory Committee on Water Resources, Springfield.

For primary bibliographic entry see Field 04A.  
W71-03806

#### RESTORING THE QUALITY OF OUR ENVIRONMENT.

President's Science Advisory Committee, Washington, D.C. Environmental Pollution Panel.

For sale by the Superintendent of Documents, US Government Printing Office, Washington, DC 20404, Price \$1.25. Report of the Environmental Pollution Panel, President's Science Advisory Committee, Washington, D.C., Nov 1965. 317 p, 11 append.

## Field 06—WATER RESOURCES PLANNING

### Group 6E—Water Law and Institutions

Descriptors: \*Investigations, \*Pollutant identification, \*Federal government, \*Environmental effects, Integrated control measures, Waste identification, Regulation, State governments, Local governments, Interstate, Water pollution sources, Water pollution control, Water resources development, Dredging, Municipal sewage, Salinity, Mine wastes, Domestic wastes, Public health, Interstate compacts, Legal aspects, Effluents, Political aspects, Project planning, Water pollution effects.

Recommendations for federal, state, and local action to restore the quality of the environment are set forth in this comprehensive appended examination of the effects and sources of pollution. The study encompasses the: (1) health effects of pollution, (2) polluting effects of detergents, (3) deterioration of materials and urban environments, and (4) climatic effects of pollution. The sources of pollution considered in this study are: (1) municipal and industrial sewage, (2) animal wastes, (3) mining wastes, (4) consumer wastes, and (5) unintentional releases of pollutants. Actions are proposed in twenty-eight areas of environmental concern. Among the proposals in the establishment of interstate compacts and entities to protect coastal marshes, lagoons, estuaries, river basins, and other water resources. Other proposals of the panel include: (1) a system of 'effluent charges' on polluters, (2) the creation of governmental groups to deal with outmoded sewerage systems, (3) the denial of federal funds for construction not minimizing dust and sediment in watersheds; (4) the consideration of salinity problems in agricultural planning, and (5) an examination of the environmental effects of granting dredging permits. The report also recommends programs in the areas of base-line measurement, development and demonstration of pollution control technology, research, and manpower. (Earl-Florida)  
W71-03807

#### FLORIDA'S WATER RESOURCES (ASSESSMENT OF LEGAL CHANGES NECESSARY TO UTILIZE FULLY FLORIDA'S WATER RESOURCES)

Florida Water Resources Study Commission, Gainesville.

Florida's Water Resources, Florida Water Resources Study Commission, Gainesville, Fla., Dec 1956. 91 p, 46 fig, 9 tab, 99 ref.

Descriptors: \*Florida, \*Water resources, \*Water policy, \*Water resources development, Water quality, Water supply, Water pollution, Hydrologic cycle, Surface water, Groundwater, Natural resources, Water utilization, Public rights, Legislation, Administration, Riparian rights, Topography, Streams, Water pollution control, Erosion, Administrative agencies, State governments, Legal aspects.

By the Florida Water Resources Study Commission, this report to the governor and the legislature gives an overall evaluation of the state's water resources and the problems and needs facing the state. Chapter 1 outlines water problems of Florida and provides a county-by-county assessment of: (1) diffused surface water; (2) streams, lakes and canals; (3) groundwater; and (4) tidal waters. Chapter 2 discusses existing water laws of Florida. Subjects include: (1) the riparian system, (2) navigability and governmental powers, (3) drainage legislation, (4) pollution control legislation, (5) diffused surface waters, (6) groundwaters and (7) the interrelationships between waters in different categories. Solution of legal problems is discussed. Chapter 3 gives facts about Florida's water resources. Chapter 4 discusses present water resources programs. Local, state, educational, and federal agency activities receive attention. Chapter 5 summarizes findings and conclusions and evaluates the adequacy of resources, the state of law, and water quality. Chapter 6 outlines commission recommendations, which include: (1) enactment of a comprehensive water law, preserving insofar as possible existing rights of Florida water users; and

(2) establishment of an agency to administer the new law and insure optimum utilization of state water resources. (Duss-Florida)  
W71-03843

W71-03773

### 6F. Nonstructural Alternatives

#### PRELIMINARY REVIEW AND ANALYSIS OF FLOOD CONTROL PROJECT EVALUATION PROCEDURES

INTASA, Menlo Park, Calif.

N. V. Arvanitidis, R. L. Lind, J. Rosing, and G. P. Johnson.

Available from NTIS as AD-713 482, \$3.00 in paper copy, \$0.95 in microfiche. U.S. Army Engineer Institute for Water Resources Final Report No IRR-70-01, IWR-70-3 Sept 1970. 131 p, 28 fig, 13 tab, 10 ref. Contract DACW07-70-C-0050.

Identifiers: \*Floods, Control, Protection, Damage, Management planning, Simulation, Costs, Terrain, Law, Maintenance, Economics, Statistical analysis, Reviews. \*Flood control, Flood plain management, Land enhancement.

The study clarifies the economic consequences and effects of programs designed to protect or otherwise manage flood plains. A firm basis is established to appropriately distinguish between the source of change of a flood plain development from its economic effects. Alternative techniques for the measurement of benefits are presented. Where the development in the flood plain will be the same with and without the project, benefits attributable to the project will equal total damages reduce. Where there is project induced growth, the benefits attributable to the project are equal to the net increase in productivity of the economy due to the relocation of activities both inside and outside the flood plain. Benefits from project induced growth (so-called 'land enhancement' benefits) can be measured by the difference between the net income (profits) of activities which move into the flood plain with protection and the net income they could earn outside the flood plain. In the absence of direct observation of change in net income, benefits from project induced growth can be measured in terms of simulating damages reduced to new activities that would locate in the flood plain with protection.  
W71-03531

#### NON-STRUCTURAL METHODS OF FLOOD-PLAIN MANAGEMENT: IDENTIFICATION, EVALUATION, AND SELECTION

Illinois Univ., Urbana.

William Eugene Fraser.

M. Landscape Arch Thesis, Illinois University, 1970. 73 p, 10 fig, 3 tab, 80 ref. OWRR Project A-030-ILL (1).

Descriptors: \*Non-structural alternatives, \*Flood protection, Flood plain zoning, Land use, Legal aspects, Planning, Water management (Applied), Regulation, Flood plain insurance, Zoning, Taxes. Identifiers: \*Flood plain management.

Non-structural methods of floodplain management are listed. Various methods were evaluated as to their suitability for reducing flood damages, and a process of selecting one or several of the methods that best meet the needs of the individual, agency, or community was developed. Non-structural methods of floodplain management can be arranged into three general groups: (1) methods to protect the health and safety of the floodplain residents, (2) methods to inform the floodplain residents of the flood hazards, and (3) methods to regulate the development on the floodplains. (K-napp-USGS)  
W71-03730

#### A UNIFIED NATIONAL PROGRAM FOR MANAGING FLOOD LOSSES

Task Force on Federal Flood Control Policy, Washington, D.C.

For primary bibliographic entry see Field 06E.

### 6G. Ecologic Impact of Water Development

A WATER RESOURCES ECOLOGY CAPABILITY FOR THE WATERWAYS EXPERIMENT STATION AND CORPS OF ENGINEERS, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

For primary bibliographic entry see Field 09C.  
W71-03318

ARTHROPOD ABUNDANCE IN COTTON IN RELATION TO SOME CULTURAL MANAGEMENT VARIABLES, California Agriculture Experiment Station, Davis. T. F. Leigh, D. W. Grimes, H. Yamada, J. R. Stockton, and Dick Bassett.

Tall Timbers Conference On Ecological Animal Control By Habitat Management, Tallahassee, Florida, Proceedings, p 71-83, February 27-28, 1969. 9 fig, 12 ref.

Descriptors: \*Cotton, \*Agronomy, \*Nitrogen, \*Irrigation effects, \*Insects, Insect control, Mites, Arid climates, California, On-site data collections, Irrigation practices, Ecology, Fertilizers, Pest control, Water distribution (Applied), Water utilization, Animal behavior, Animal populations, Environmental effects, Temperature, Ecosystems, Humidity, Crops, Microenvironment, Crop response, Sampling, Southwest U.S., Plant growth. Identifiers: \*Arthropods, \*Crop pests, Spider mites.

The arid Southwest irrigation and N-fertilizers have very strong influences on growth and fruiting of cotton plants. Temperature and humidity within the canopy are also affected. Insects respond differentially to environmental changes and therefore, the effects of water and N variables on the crop ecosystem should elicit responses in insect populations. In 2 different seasons (1962 and 1968) and in 2 different southern California locations, cotton plots were treated with factorial combinations of irrigation schedules and N-application. At the end of the growing season, measurements were made of plant heights and populations of spider mites, lygus bugs (*Lygus hesperus knight*) and predatory big-eyed bugs (*Geocoris pallens Stal*). Three-dimensional graphs of N and water applications and field measurements were constructed. Increase in either management variable produced increases in plant growth. Highly significant differences in insect numbers between some treatments were demonstrated, indicating strong correlations between phytophagous insect abundance and agronomic practices. All results are preliminary and not conclusive. (Casey-Arizona)  
W71-03342

SOME CONSIDERATIONS FOR WATER QUALITY AND ENVIRONMENTAL PROTECTION IN WILD AND SCENIC RIVER DEVELOPMENT: THE CHATTOOGA RIVER - A CASE STUDY, Forest Service (USDA), Southern Region.

For primary bibliographic entry see Field 05G.  
W71-03388

#### WHAT IS CONSERVATION,

Resources for the Future, Inc. Washington, D.C. For primary bibliographic entry see Field 06B.  
W71-03639

## 07. RESOURCES DATA

### 7A. Network Design

#### GEOMORPHOLOGY AT THE CENTRAL ARID ZONE RESEARCH INSTITUTE, INDIA,

International Inst. for Aerial Survey and Earth Sciences, Delft (Netherlands).

H. T. Verstappen.

Nature and Resources, Vol 4, No 3, p 6-9, September 1968.

**Descriptors:** \*Surveys, \*Geomorphology, \*Arid lands, \*Aerial photography, \*Data collections, Rivers, Meanders, Hydrology, Weathering, Drainage systems, Alluvium, Granites, River basins, River flow, Dunes, Sands, Environmental effects, Flood plains, Erosion, Geological surveys, Hydrogeology, Land forming, Regional analysis, Structural geology, Terrain analysis, Topography, Data processing, Hydrologic data, Maps, Research facilities.

**Identifiers:** \*India, \*Block development surveys.

The Central Arid Zone Research Institute (CAZRI) currently has 5 divisions with 2 more planned. In one of the largest, the Basic Resources Studies Division, block studies are central to data accumulation and map construction and are followed by full integration between the studies and their immediate use. Geomorphology has been recognized as a key factor and stereoscopic studies of aerial photographs have been extensively undertaken. Some important geomorphological research projects currently in progress are: (1) orientation and geomorphology of dunes/sand grains involving moisture retention and grain cementation, (2) quantitative geomorphology of drainage basins, linking geomorphology to hydrology and obtaining estimates of river load and runoff, (3) river meandering behavior leading to practical considerations for bridge building, (4) former drainage channels which give insights into current salinity and subsurface water distributions and (5) granitic weathering and its resulting effects on surface water infiltration. Much of the work is extensively interdisciplinary. Recommendations are made for future studies. (Casey-Arizona)

W71-03339

#### SOLAR RADIATION AND THE USE OF IT BY PLANTS,

Main Geophysical Observatory, Leningrad (USSR).

For primary bibliographic entry see Field 021.  
W71-03344

#### INSTRUMENTATION AND DEVELOPMENT OF TECHNIQUES TO MEASURE AND EVALUATE METEOROLOGICAL PARAMETERS IMPORTANT TO HYDROLOGY,

Utah Water Research Lab., Logan.

Duane G. Chadwick.

Available from NTIS as PB-196 726, \$3.00 in paper copy, \$0.95 in microfiche. Utah State University Water Research Laboratory Report PRCWRR 12-1, November 1, 1970. 39 p, 36 fig, 8 ref, append. OWRR Project A-002-UTAH (3).

**Descriptors:** \*Telemetry, \*Hydrologic data, \*Gaging stations, \*Data transmission, Instrumentation, Precipitation gages, Snow surveys, Data collections, Computers, Measurement, Analog computers, Snowpacks, Water yield.

**Identifiers:** \*Snow depth gages, \*Water content (Snow).

A hydrologic data telemetering system was designed to have the highest accuracy of any FM/FM telemetering system known. The repeatability of readout approaches 0.05%. This accuracy is not appreciably deteriorated in the presence of high noise levels in radio telemetry transmissions. This high accuracy is obtained by: (a) a frictionless transducer; (b) a specially designed tracking filter;

(c) a wide-range frequency deviation of plus or minus 40% permitting greater resolution and accuracy; (d) readout subsequently converted to usable units by aid of a digital computer; and (e) locating the electronics and the transducer in a temperature stable environment, underground. The frictionless transducer technique was used in developing a low-displacement type pressure transducer for measuring the water-content of snow. A method was developed for the automatic plotting of isohyetal lines on an analog computer. (Knapp-USGS) W71-03376

#### BRIDGER INSTRUMENT MODIFICATION,

Montana State Univ., Bozeman. Water Resources Research Center.

Duain Bowles.

Available from NTIS as PB-196 727, \$3.00 in paper copy, \$0.95 in microfiche. Montana University Joint Water Resources Research Center Report No 2, September 1966. 30 p. OWRR Project B-006-MONT (1).

**Descriptors:** \*Instrumentation, \*Telemetry, \*Data transmission, Water levels, Thermometers, Data collections, Weather data, Electronic equipment, Snow cover, Calibrations, Network design, Snowpacks, Computers, Data processing.

**Identifiers:** \*Bridger (Mont), Weather data telemetry, \*Telemetry networks.

Modifications were designed for operation on the Belfort Universal Raingage, the Leopold-Stevens Water level Recorder, and the Belfort Recording Microbargraph. In addition, thermistor thermometers were constructed to operate at the research areas thermograph locations. Specifically, the modifications were designed to permit electrical interrogation of existing devices now being operated at the Bridger, Montana research area to provide a resistive readout. Calibration tests were conducted to verify that the instrument modifications met the design requirements. Corrections for temperature effects upon the various potentiometers can be made in analysis of the data or on site by installation of a compensation device such as a thermistor. (See also W71-03377 thru W71-03379) (Knapp-USGS)

W71-03376

#### BRIDGER HYDROMETEOROLOGICAL RESEARCH AREA AND FACILITIES,

Montana State Univ., Bozeman. Water Resources Research Center.

R. J. Rickabaugh.

Available from NTIS as PB-196 728, \$3.00 in paper copy, \$0.95 in microfiche. Montana University Joint Water Resources Research Center Report No 4, January 1967. 26 p. OWRR Project B-006-MONT (2).

**Descriptors:** \*Instrumentation, \*Telemetry, \*Data transmission, Water levels, Thermometers, Data collections, Weather data, Electronic equipment, Snow cover, Calibrations, Network design, Snowpacks, Computers, Data processing.

**Identifiers:** \*Bridger (Mont), Weather data telemetry, \*Telemetry networks.

The Bridger Hydrometeorological Research Area, University of Montana, is located 20 miles north of Bozeman on Highway 293, on the east slope of the Bridger Mountain Range. There are now over 225 miles of insulated copper conductor in this area for collection and transmittal of field data. This outdoor laboratory overlaps the Bridger Bowl ski area. The cable complex fans out from the 'Bridge Data Center', a building located near the center of the complex at about 6,500 ft. elevation. It is accessible by car in any season of the year. The electronics equipment converts the incoming data from research sites into coded form for transmission to the campus. The remote control for the transmitter that transmits digital information to the University is also located in this building. Meters at this location give wind speed and direction at the ridge of the mountain range, half way up the slope, and at

the data center. On the ridge of the range the University built a 10' x 12' 'A' frame shelter fully insulated and having commercial power for heat, lights, etc. It is also a terminal for a 100 conductor cable originating one mile down the slope in the Data Center. A transmitter located here is part of the telemetry system. Commercial power can be extended from this point to other locations on the ridge. (See also W71-03376) (Knapp-USGS) W71-03377

#### BRIDGER TELEMETRY COMMUNICATIONS SYSTEMS,

Montana State Univ., Bozeman. Water Resources Research Center.

Robert E. Leo.

Available from NTIS as PB-196 729, \$3.00 in paper copy, \$0.95 in microfiche. Montana University Joint Water Resources Research Center Report No 5, January 1967. 11 p, 13 fig. OWRR Project B-006-MONT (3).

**Descriptors:** \*Instrumentation, \*Telemetry, \*Data transmission, Water levels, Thermometers, Data collections, Weather data, Electronic equipment, Snow cover, Calibrations, Network design, Snowpacks, Computers, Data processing.

**Identifiers:** \*Bridger (Mont), Weather data telemetry, \*Telemetry networks.

The Bridger Telemetry Communications System provides Frequency Modulation (FM), Very high Frequency (VHF), radio equipment in order to transmit digital hydrometeorological data from the Bridger Mountain area north of Bozeman, Montana, to the Electronics Research Laboratory on the campus of Montana State University, Bozeman, Montana. Either a voice or data mode may be used. The voice mode may be used to communicate in both directions over the link for maintenance purposes and in normal operations is very seldom used. The data mode provides for transmission on 171.9 MHz of digital data in one direction only — from Bridger to ERL. The equipment is entirely 110 volt AC operated at the ERL end of the link and at the Bridger Data Center. The ridge transmitter is operated from a 12 volt car battery which is kept charged from a trickle charger. (See also W71-03376) (Knapp-USGS)

W71-03378

#### BRIDGER HYDROMETEOROLOGICAL DATA ACQUISITION SYSTEM,

Montana State Univ., Bozeman. Water Resources Research Center.

Lee E. Cannon.

Available from NTIS as PB-196 730, \$3.00 in paper copy, \$0.95 in microfiche. Montana University Joint Water Resources Research Center Report No 6, February 1967. 32 p, 3 append. OWRR Project B-006-MONT (4).

**Descriptors:** \*Instrumentation, \*Telemetry, \*Data transmission, Water levels, Thermometers, Data collections, Weather data, Electronic equipment, Snow cover, Calibrations, Network design, Snowpacks, Computers, Data processing.

**Identifiers:** \*Bridger (Mont), Weather data telemetry, \*Telemetry networks.

The Data Acquisition System installed at Bridger Bowl, Montana, was designed and constructed to record a wide variety of hydrometeorological parameters in a computer compatible form. The system consists of power supplies to operate the system; digitizers; even counters; programmable scanner and clock; controller to accept signals from the digitizers, the event counters, the scanner, and the clock, and to generate the output record; and the terminal board. The system is capable of interrogating up to 99 channels of information. Of these, any five may be connected to the five 3-digit event counters. Any parameter which can be normalized in the 0-300 microampere range can be recorded by the system. (See also W71-03376) (Knapp-USGS)

W71-03379

## Field 07—RESOURCES DATA

### Group 7A—Network Design

#### RELIABILITY OF A VARIANCE ESTIMATE OBTAINED FROM A SAMPLE AUGMENTED BY MULTIVARIATE REGRESSION, Geological Survey, Arlington, Va.

E. J. Gilroy.  
Water Resources Research, Vol 6, No 6, p 1595-1600, December 1970. 6 p, 3 ref.

Descriptors: \*Regression analysis, \*Date collections, \*Sampling, \*Networks, Gaging stations, Hydrologic data, Statistical methods, Variability.  
Identifiers: \*Multivariate regression.

A sample augmented by multivariate regression estimates was used to estimate the population variance associated with the sample. The sampling variance of the estimator obtained from the lengthened sample was derived and compared with the sampling variance computed from the original unaugmented sample. The relative reliability of the variance estimate based on the original observations is found to depend on the multiple correlation between the original and the augmenting variables. One application of these results is found in the design of gaging station networks. Given an existing set of gaging stations and faced with the decision of which subset of stations to retain, the network designer may wish to give consideration to estimating both the mean and the variance at the discontinued sites. A discontinued site would then correspond to the variable with the short sample record. The results given will aid in this decision making process. (Knapp-USGS)

W71-03675

#### COMPARING POWER SPECTRA COMPUTED BY BLACKMAN-TUKEY AND FAST FOURIER TRANSFORM,

United States Lake Survey, Detroit, Mich.  
For primary bibliographic entry see Field 02E.  
W71-03676

#### ESTIMATION OF BASIN PRECIPITATION BY REGRESSION EQUATION, Meteorological Service of Canada, Toronto (Ontario).

For primary bibliographic entry see Field 02B.  
W71-03691

#### ON TESTING THAT THE DISTRIBUTION OF EXTREMES IS OF TYPE I WHEN TYPE II IS THE ALTERNATIVE, Agricultural Univ., Wageningen (Netherlands).

For primary bibliographic entry see Field 02E.  
W71-03697

## 7B. Data Acquisition

#### INSTRUMENTATION AND DEVELOPMENT OF TECHNIQUES TO MEASURE AND EVALUATE METEOROLOGICAL PARAMETERS IMPORTANT TO HYDROLOGY, Utah Water Research Lab., Logan.

For primary bibliographic entry see Field 07A.  
W71-03375

#### BRIDGER INSTRUMENT MODIFICATION, Montana State Univ., Bozeman. Water Resources Research Center.

For primary bibliographic entry see Field 07A.  
W71-03376

#### BRIDGER HYDROMETEOROLOGICAL RESEARCH AREA AND FACILITIES, Montana State Univ., Bozeman. Water Resources Research Center.

For primary bibliographic entry see Field 07A.  
W71-03377

#### BRIDGER TELEMETRY COMMUNICATIONS SYSTEMS, Montana State Univ., Bozeman. Water Resources Research Center.

For primary bibliographic entry see Field 07A.  
W71-03378

#### BRIDGER HYDROMETEOROLOGICAL DATA ACQUISITION SYSTEM, Montana State Univ., Bozeman. Water Resources Research Center.

For primary bibliographic entry see Field 07A.  
W71-03379

#### THE USE OF FALLOUT CESIUM-137 AS A TRACER OF SEDIMENT MOVEMENT AND DEPOSITION,

Agricultural Research Service, Oxford, Miss., Sedimentation Lab.

Jerry C. Ritchie, J. Roger McHenry, Angela C. Gill, and Paul H. Hawks.

In: Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ. Water Resources Research Institute, p 149-162, 1970. 14 p, 3 fig, 2 tab, 13 ref. OWRR Project A-999-Miss (6).

Descriptors: \*Tracers, \*Tracking techniques, \*Sediment transport, \*Fallout, \*Tagging, Mississippi, Silting, Provenance, Reservoir silting, Sediment yield, Soil erosion, Deposition (Sediments), Cesium.

Identifiers: \*Sediment movement tracers.

Radioactive fallout tags soil particles with identifiable radioisotopes so that movement of these particles can be followed through the sedimentation process. The content of cesium-137, a gamma emitter (0.662 Mev) and a fallout product, was determined in a number of selected soils and sediments from the Little Tallahatchie River Watershed above Sardis Dam, Mississippi. The variation in measured concentrations of cesium-137 in sediment profiles can be related to periods of maximum fallout. The age of the upper sediments and the rate of deposition can be estimated. A greater depth and rate of sediment accumulation were found in the deeper parts of the reservoir area sampled. The recent (1963-69) rate of sedimentation is less than in prior years (1959-63). Soils under forest cover contain more cesium-137 than those under grass. Where soils have eroded, cesium-137 content is less. The cesium-137 content is less in sandy soils than in finer textured soils because of the differences in ion exchange capacity of the soils. (See also W71-03380). (Knapp-USGS)

W71-03385

#### INTERFERENCE STUDIES IN THE DETERMINATION OF SODIUM, POTASSIUM, CALCIUM, AND MAGNESIUM IN NATURAL WATERS BY ATOMIC ABSORPTION SPECTROPHOTOMETRY,

Agricultural Research Service, Oxford, Miss., Sedimentation Lab.

For primary bibliographic entry see Field 02K.  
W71-03386

#### A NEW SIMPLIFIED INSTRUMENT FOR WATER TEMPERATURE MEASUREMENTS, Swedish Meteorological and Hydrological Inst., Stockholm.

Oscar Cabelis.  
Nordic Hydrology, Vol 1, No 4, p 209-215, 1970. 7 p, 6 fig, 4 ref.

Descriptors: \*Water temperature, \*Bathymeterographs, \*Thermometers, Instrumentation, Depth, Equipment, Measurement, Calibrations.  
Identifiers: \*Thermistors.

Through the rapid development in the field of electrotechniques and the development of highly sophisticated precision components it has been possible to design a new simplified electrical instrument for the measurement of water temperature. This instrument consists of a bridge, a thermistor probe with leads, and a galvanometer. The instrument has been used for five years under extreme weather

conditions. The instrument has shown very reliable readings. The most recent version of the probe may be used in salt water at depths as great as 200 meters. Measurements can probably be made considerably deeper with good reliability. (Knapp-USGS)

W71-03391

#### SEISMIC REFRACTION AND ELECTRICAL RESISTIVITY: TOOLS IN GROUNDWATER EXPLORATION,

Iowa State Univ., Ames. Dept. of Earth Science.

Lyle V. A. Sendlein.

American Society of Agricultural Engineers Transactions, Vol 11, No 6, p 890-892, 1968. 3 p, 4 fig, 7 ref. OWRR Project A-012-IA (2).

Descriptors: \*Seismic studies, \*Electrical studies, \*Geophysics, \*Surveys, \*Electrical well logging, Groundwater, Water resources development, Aquifers, Water quality, Resistivity.  
Identifiers: \*Groundwater exploration.

The coordinated use of geophysics and geology applied to groundwater problems helps provide maximum geologic information from a minimum investment. The reliability of the study depends on data density, which is related to the amount of money invested in the study. A coordinated approach will also supply more information per dollar invested than a study composed of bore-hole information alone. Application of geophysical methods without additional geologic information reduces the level of reliability of geophysical data. (Knapp-USGS)

W71-03439

#### A CONTROLLED DEPTH, VOLUMETRIC BOTTOM SAMPLER,

For primary bibliographic entry see Field 05A.

W71-03449

#### AN EVALUATION OF THE INFRA-RED THERMOMETER AS AN AIRBORNE INDICATOR OF SURFACE WATER TEMPERATURES, Department of Transport, Toronto (Ontario). Meteorological Branch.

T. L. Richards, and D. G. Massey.  
Manuscript, October 29, 1965. 24 p, 14 fig, 7 tab, 8 ref.

Descriptors: \*Water temperature, \*Infra-red radiation, \*Evaporation control, \*Weather data, Meteorology, Remote sensing, Evaporation, Lakes, Reservoirs, \*Great Lakes, Lake Ontario.  
Identifiers: \*Infra-red thermometer, \*Airborne radiation thermometer.

Obtaining data on surface water temperatures is of value to many uses. It is most useful for forecasting meteors logical conditions over the lakes and their adjacent land areas and for assessing water losses through evaporation and in studies of the formation and dissipation of ice. An infra-red thermometer (IRT) was installed on an aircraft as an airborne radiation thermometer (ART) and subjected to a program of test and evaluation as an instrument for these measurements over the Great Lakes. The first phase of the program dealt with the mounting and exposure of the sensor. The second, in conjunction with the research vessel 'Poste Dauphine' dealt mainly with operational and theoretical aspects of the technique. It is concluded that, although the exposure of the sensor is critical, the ART, when used in suitable weather and with proper calibration checks, provides a good technique for making fast and reliable water temperature surveys of the Great Lakes. The optimum height for such surveys appears to be 500 feet or lower; however, if necessary, flights at one or two thousand feet appear to be feasible with proper calibration. Absolute and relative accuracies appear to be of the orders of 1.0 deg C and 0.5 deg C respectively. (Herrera-Vanderbilt)

W71-03466

**SAMPLING CONSIDERATIONS IN STREAM DISCHARGE AND TEMPERATURE MEASUREMENTS,**  
Pittsburgh Univ., Pa.  
R. G. Quimpo, and J. Y. Yang.  
Water Resources Research, Vol 6, No 6, p 1771-1774, December 1970. 3 fig, 10 ref.

Descriptors: \*Sampling, \*Temperature, \*Time series analysis.  
Identifiers: Auto correlation coefficient, Stream discharge, Time interval.

The choice of a sampling interval in hydrometry is constrained by two extremes, redundant information from sequentially correlated observations resulting from sampling too often, and lost information because of too infrequent sampling. The variability of the sample variance is used to obtain a sampling interval at some level of information redundancy. This statistic is suggested as an alternative measure of information content to the one based on the variance of the sample mean time series of stream discharge and temperature measurements are used to illustrate application of the theory. While the data treated were confined to streamflow and temperature, the technique may be applied to other variables in water resources. (Upadhyaya-Vanderbilt)  
W71-03476

**RADAR MEASUREMENT OF PRECIPITATION RATE,**  
National Science Foundation, Washington, D.C.  
Special Foreign Currency Science Information Program.  
A. M. Borovikov, V. V. Kostarev, I. P. Mazin, V. I. Smirnov, and A. A. Chernikov.  
Translation of Radiolokatsionnye Izmereniya Osadkov. Leningrad, 1967. Available from NTIS as TT-69-55101, \$3.00 in paper copy, \$0.95 in microfiche. Israel Program for Scientific translations, Jerusalem, 1970. 112 p.  
Identifiers: \*Meteorological radar, Precipitation (Meteorology), \*Precipitation (Meteorology), Measurement, Radio waves, Attenuation, Reflection, Radar detection, Radar equipment, Radar cross sections, Radar signals, Microstructure, Errors, Accuracy, Data processing, USSR, Translations.

Methods of radar measurement of precipitation: Physical principles of the measurement of precipitation by the radar signal intensity; Equipment and procedure for obtaining radar precipitation data; Observational procedure and data processing: Results of comparative observations.  
W71-03527

**A PORTABLE, AUTOMATIC WATER SAMPLER,**  
Forest Service (USDA), Ogden, Utah. Intermountain Forest and Range Experiment Station.  
Robert D. Doty.  
Water Resources Research, Vol 6, No 6, p 1787-1788, December 1970. 2 p, 2 fig.

Descriptors: \*Automation, \*Sampling, \*Water quality, Chemical analysis, Equipment, Instrumentation.  
Identifiers: \*Automatic water-samplers.

A water sampler is designed to operate where no outside source of power is available and where access to the point of sampling is difficult. The sampler is lightweight, battery powered, and automatically bottles 16 samples at present time intervals between servicings. (Knapp-USGS)  
W71-03695

**A SALT TRACING METHOD FOR MEASURING CHANNEL VELOCITIES IN SMALL MOUNTAIN STREAMS,**  
Maine Univ., Orono; and Sleepers River Research Watershed, Danville, Vt.  
Darryl Calkins, and Thomas Dunne.

Journal of Hydrology, Vol 11, No 4, p 379-392, November 1970. 14 p, 5 fig, 2 tab, 18 ref.

Descriptors: \*Discharge measurement, \*Tracers, \*Tracking techniques, \*Small watersheds, \*Stream gages, Electrolytes, Saline water, Mixing, Water storage, Hydrograph analysis, Velocity, Channel morphology, Discharge (Water), Rainfall-runoff relationships, Vermont.

Identifiers: Experimental watersheds.

Because measuring or calculating channel velocities in small mountain streams is very difficult due to the high variability of the channel geometry parameters and roughness characteristics, a salt tracing procedure was examined. The technique is simple and quick, using materials that are commonly available at most research watersheds and water resource centers. The velocity through the channel reach using the salt tracing method was found to be a better representation of the average stream velocity than that computed by the continuity equation at three channel cross sections. (Knapp-USGS)  
W71-03700

#### REMOTE RECORDING PRECIPITATION GAGE,

N. A. Zykova.

Trans from Trudy Gosudar. Gidrol. INST-TA, No 168, 1969. Soviet Hydrology: Selected Papers, No 4, p 351-356, 1969. 6 p, 2 fig, 2 tab, 2 ref.

Descriptors: \*Precipitation gages, \*Telemetry, Automation, Instrumentation, Calibrations, Equipment, Gaging stations, Snowfall, Rainfall, Precipitation (Atmospheric).  
Identifiers: \*Automatic precipitation gages, USSR.

The Valdai Hydrologic Scientific Research Laboratory, USSR, designed a remote recording (totalizing) precipitation gage. This gage is portable and consists of separate receivers for liquid, solid, and mixed precipitation, a pulse detector, remote communication lines, and a battery power supply. The pulse detector is a plastic tipping vessel. It was found that the precipitation measured with the remote-recording precipitation gage differs little from that measured with the sunken rain gage. (Knapp-USGS)  
W71-03711

#### RADIOMETRIC METHODS OF MEASURING THE SOIL MOISTURE CONTENT,

A. M. Dimaksyan, and N. P. Glazkov.

Trans from Trudy Gosudar. Gidrolog. Inst-Ta, No 168, 1969. Soviet Hydrology: Selected Papers, No 4, p 333-351, 1969. 19 p, 15 fig, 1 tab, 18 ref.

Descriptors: \*Soil moisture meters, \*Nuclear moisture meters, Reviews, Instrumentation, Calibrations, Moisture content, Nuclear meters, Soil density probes, Soil moisture.  
Identifiers: Neutron moisture meters, USSR.

Methods of determining soil moisture are reviewed and new radiometric methods developed in the USSR are described. The State Hydrologic Institute has investigated the neutron method from 1965 to 1968. It was found that moisture measurements with neutron moisture meters and their calibration are best performed through the cadmium ratio. The determination of the soil moisture content reduces to measurements of the ratio count rate of moderated neutrons with a cadmium shield to those without it. This considerably reduces instrument errors and errors associated with the instability of the neutron source, while the measurement range broadens to 100%. The cadmium ratio is a reliable quantitative characteristic of soil moisture. This ratio increases monotonically from 1 to 18 as the moisture content changes from 0 to 100%. With this in view, the Isotope and Radic Electronics Section of the State Hydrologic Institute has developed and constructed instruments for measuring soil moisture at the surface and in the deeper layers. (Knapp-USGS)  
W71-03712

**CONTROL MEASUREMENTS ON DAMS. RAPID SURVEY METHODS,**  
Electro-Watt Engineering Services Ltd., Zurich (Switzerland).

For primary bibliographic entry see Field 08A.  
W71-03742

**SAFETY AND BEHAVIOUR OF CONCRETE DAMS. METHODS OF OBSERVATIONS AND ORGANIZATION,**  
For primary bibliographic entry see Field 08A.  
W71-03743

#### 7C. Evaluation, Processing and Publication

#### STREAMFLOW GENERATING TECHNIQUES: A COMPARISON OF THEIR ABILITIES TO SIMULATE CRITICAL PERIODS OF DROUGHT,

California Univ., Los Angeles. School of Engineering and Applied Science.  
For primary bibliographic entry see Field 02F.  
W71-03314

**WATERHAMMER ANALYSIS BY THE METHOD OF CHARACTERISTICS,**  
Bologna Univ. (Italy).  
For primary bibliographic entry see Field 08B.  
W71-03357

#### HURRICANE CAMILLE ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN MISSISSIPPI,

Geological Survey, Jackson, Miss.  
James W. Hudson.

In: Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ. Water Resources Research Institute, p 29-32, 1970. 4 p. OWRR Project A-999-MISS (6).

Descriptors: \*Hurricanes, \*Floods, \*Mississippi, \*Mapping, \*Surveys, Flood damage, Maps, Data collections, Hydrologic data, Water levels, Publications, Waves (Water).  
Identifiers: \*Hurricane Camille (1969), U. S. Geological Survey, \*Flood mapping.

On November 10, 1969, 12 weeks after Hurricane Camille hit the Mississippi gulf coast the U. S. Geological Survey made public distribution of 14 Hydrologic Atlases showing highwater elevations and the area inundated by the floodwater accompanying the hurricane. These atlases are the culmination of effort that began within 12 hours after the hurricane came ashore in the Bay St. Louis-Pass Christian area. Excluding printing, the cost of the atlases was about \$14,000. Behind the Geological Survey's effort to get this information to the public as quickly as possible was the realization that any realistic and effective settlement of insurance claims and the plans for rebuilding in the devastated area would require the delineation of land area flooded. Through close cooperation at all levels, the Survey was able to produce in three months a series of maps that normally requires one to two years to complete. (See also W71-03380). (Knapp-USGS)  
W71-03381

**DOWSING EXPERIMENTS,**  
Institute for Industrial Research and Standards, Dublin (Ireland).  
R. A. Foulkes.

Nature, Vol 229, No 5281, p 163-168, January 15, 1971. 6 p, 7 fig, 5 tab, 3 ref.

Descriptors: \*Dowsing, \*Subsurface investigations, \*Groundwater, Methodology, Testing, Evaluation.  
Identifiers: \*Dowsing evaluation (Great Britain), Controlled testing.

The results of several methods of dowsing under controlled experiments organized by the British

## Field 07—RESOURCES DATA

### Group 7C—Evaluation, Processing and Publication

Army and Ministry of Defense are presented. The results obtained seem no more reliable than a series of guesses, as indicated in the following experiment. A test of the ability to detect flowing water was arranged with the cooperation of an experienced dowser. A 2-inch polythene pipe carried the water under a lawn and was controlled by a stopcock which the dowser could not see. He was asked to say whether or not the water was flowing in a series of twenty-five trials, the stopcock being on or off in a prearranged random sequence. He used a V shaped rod (rose cuttings) and walked across the line of the pipe to give his verdict. Two sequences were carried out giving fifty results. The water was flowing in twenty-five of these. The dowser was correct in nine cases of water flowing and in sixteen of it not flowing, that is, he was correct in twenty-five out of fifty cases. This is entirely consistent with chance (guessing) and shows no evidence of being able to detect flowing water. (Woodard-USGS)

W71-03389

**AN IMPLEMENTATION OF STAGE-FALL-DISCHARGE RELATIONSHIP ON DIGITAL COMPUTERS,**  
Norges Vassdrags- og Elektrisitetsvesen, Oslo.  
For primary bibliographic entry see Field 02E.  
W71-03393

**COMPILATION OF HYDROLOGIC DATA, DEEP CREEK, COLORADO RIVER BASIN, TEXAS, 1968.**  
Geological Survey, Austin, Tex. Water Resources Div.

Geological Survey Report, 1970. 86 p, 2 fig, 4 tab.

Descriptors: \*Rainfall-runoff relationships, \*Data collections, \*Surface waters, \*Hydrologic data, \*Flood protection, \*Texas, Watershed management, Flood control, Levees, Floods, Streamflow, Rainfall, Runoff, Erosion, Sediment transport, Water quality, Chemical analysis, Gaging stations, Stream gages, Discharge measurements, Flow rates, Peak discharge, Average flow, Reservoirs, Water storage, Storage capacity, Water resources, Reservoir stages.  
Identifiers: \*Data compilation (Hydrologic), \*Deep Creek (Tex).

Runoff and storage data collected during the 1968 water year (October 1967-September 1968) for the 43.9-square-mile area above the stream-gaging station Deep Creek near Mercury, Texas, and the 8.31-square-mile area above the stream-gaging station Dry Prong Deep Creek near Mercury, Texas are presented. The location of floodwater-retarding structures and hydrologic instruments in the area are shown. These 6 structures have a combined capacity of 7,030 acre-feet and regulate floodflow from 25.3 square miles. The weighted-mean rainfall over the Deep Creek study area for the water year was 35.13 inches and 33.05 inches over the Dry Prong Creek study area, or 27% above the long-term average rainfall of 27.74 inches at Brownwood. The ratio of rainfall to runoff ranged from 7.7 to 12.3% for the stations with continuous recording gages. Storm periods were selected for detailed computations. These computations include detailed time breakdown of rainfall and discharge. The water in the reservoirs contained calcium and bicarbonate as the predominant ions. The dissolved solids ranged from 133 mg/liter to 199 mg/liter. (Woodard-USGS)

W71-03398

**COMPILATION OF HYDROLOGIC DATA, HONEY CREEK, TRINITY RIVER BASIN, TEXAS, 1968.**  
Geological Survey, Austin, Tex. Water Resources Div.

Geological Survey Report, 1970. 78 p, 2 fig, 4 tab.

Descriptors: \*Rainfall-runoff relationships, \*Data collections, \*Surface waters, \*Hydrologic data, \*Flood protection, \*Texas, Watershed management, Flood control, Levees, Floods, Streamflow, Rainfall, Runoff, Erosion, Sediment transport, Water quality, Chemical analysis, Gaging stations, Stream gages, Discharge measurements, Flow rates, Peak discharge, Average flow, Reservoirs, Water storage, Storage capacity, Water resources, Reservoir stages.  
Identifiers: \*Data compilation (Hydrologic), \*Honey Creek (Tex).

Rainfall, runoff, and storage data collected during the 1968 water year (October 1967-September 1968) for the 39.0-square-mile area above the stream-gaging station Honey Creek near McKinney, Texas are presented. The location of floodwater-retarding structures and hydrologic instruments in the area are shown. The 12 structures provide capacity for temporary storage of 8,320 acre-feet of flood runoff from 20.9 square miles of the 39.0-square-mile drainage area. The average rainfall was 41.87 inches, or 121% of the 15-year (1953-68) average. The monthly-rainfall totals ranged from 1.04 inches in November to 6.22 inches in September. The mean daily discharge at the stream-gaging station Honey Creek near McKinney was 35.3 cfs, compared with the 17-year average 17.5 cfs. Annual runoff at the stream-gaging station was 25,610 acre-ft, or 12.31 inches. Three storm periods were selected for detailed computations. These computations include a detailed time breakdown of rainfall and discharge, hydrographs, and mass curves. The water in the reservoirs contained calcium and bicarbonate as the predominant ions. The dissolved solids ranged from 148 mg/liter to 209 mg/liter. (Woodard-USGS)

W71-03399

**COMPILATION OF HYDROLOGIC DATA, GREEN CREEK, BRAZOS RIVER BASIN, TEXAS, 1968.**  
Geological Survey, Austin, Tex. Water Resources Div.

Geological Survey Report, 1970. 66 p, 2 fig, 3 tab.

Descriptors: \*Rainfall-runoff relationships, \*Surface waters, \*Data collections, \*Hydrologic data, \*Flood protection, \*Texas, Watershed management, Floods, Levees, Flood control, Streamflow, Runoff, Erosion, Sediment transport, Water resources, Gaging stations, Stream gages, Discharge measurements, Flow rates, Peak discharge, Reservoirs, Water storage, Storage capacity, Reservoir stages.  
Identifiers: \*Data compilation (Rainfall-runoff), Green Creek (Tex).

Rainfall and runoff data collected during the 1968 water year (October 1967-September 1968) for the 46.1-square-mile area above the stream-gaging station Green Creek near Alexander, Texas are presented. The investigation is part of a study to define the various factors of rainfall-runoff relationships before and after floodwater-retarding structures were built. There are eight floodwater-retarding structures with a total combined capacity of 7,500 acre-feet below the flood-spillway crests, that control approximately 50 percent of the drainage area above the streamgaging station. The weighted-mean rainfall over the study area during the 1968 water year was 36.06 inches, or 114 percent of the 1931-60 long-term mean annual rainfall of 31.67 inches at Dublin, Texas. The mean daily discharge at the stream-gaging station Green Creek near Alexander was 14.6 cfs compared with the 10-year average of 5.48 cfs. The annual runoff at the stream-gaging station was 10,610 acre-feet, representing an equivalent depth of 4.32 inches. Six storm periods were selected for detailed computation. These computations include detailed time breakdown of rainfall and discharge, hydrographs, and mass curves. (Woodard-USGS)

W71-03400

**MATHEMATICAL SIMULATION OF HYDROLOGIC EVENTS OF UNGAGED WATERSHEDS,**  
Purdue Univ., Lafayette, Ind. Water Resources Research Center.  
For primary bibliographic entry see Field 02A.  
W71-03520

**INVENTORY INFORMATION ON PUBLIC LANDS, VOLUME II.**  
Public Land Law Review Commission, Washington, D.C.  
For primary bibliographic entry see Field 06E.  
W71-03528

**PARAMETERIZATION OF OBSERVED HYDROGRAPHS,**  
Vermont Univ., Burlington. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 02E.  
W71-03665

**PERSISTENCE OF PRECIPITATION AT 108 CITIES IN THE CONTERMINOUS UNITED STATES,**  
Weather Bureau, Silver Spring, Md.  
For primary bibliographic entry see Field 02B.  
W71-03673

**A GENERAL NUMERICAL SOLUTION OF THE TWO-DIMENSIONAL DIFFUSION-CONVECTION EQUATION BY THE FINITE ELEMENT METHOD,**  
California Univ., Davis.  
For primary bibliographic entry see Field 05B.  
W71-03677

**MEAN EVAPORATION OVER CANADA,**  
Meteorological Service of Canada, Toronto (Ontario).  
For primary bibliographic entry see Field 02D.  
W71-03678

**ESTIMATING EXPECTED VALUES FOR MONOTONE SAMPLES,**  
Geological Survey, Washington, D.C.; American Univ., Washington, D.C.; T. Maddock, III, and D. S. Crosby.  
Water Resources Research, Vol 6, No 6, p 1743-1745, December 1970. 3 p, 2 tab, 3 ref.

Descriptors: \*Statistical methods, \*Sampling, Correlation analysis, Variability, Data collections, Streamflow forecasting.  
Identifiers: \*Monotone samples.

New expected value estimates for monotone sample data can be produced while using the technique to produce a consistent covariance matrix. If the correlations between records are large enough, the new expected value estimates will be improved estimates because the variance of the records will be decreased by the transfer of information from the longer records to the shorter records. (Knapp-USGS)  
W71-03689

**COMPILATION OF HYDROLOGIC DATA, CALAVERAS CREEK, SAN ANTONIO RIVER BASIN, TEXAS, 1968.**  
Geological Survey, Austin, Tex. Water Resources Div.

Geological Survey Report, 1970. 66 p, 2 fig, 4 tab.

Descriptors: \*Rainfall-runoff relationships, \*Data collections, \*Surface waters, \*Hydrologic data, \*Flood protection, \*Texas, Watershed management, Flood control, Levees, Floods, Rainfall, Streamflow, Runoff, Erosion, Sediment transport, Water quality, Chemical analysis, Gaging stations, Stream gages, Discharge measurements, Flow rates, Peak discharge, Reservoirs, Water storage, Storage capacity, Reservoir stages, Water resources.

Identifiers: \*Data compilation (Rainfall-runoff), Calaveras Creek (Tex).

Rainfall, runoff, and storage data collected during the 1968 water year (October 1967-September 1968) for the 77.2-square-mile area above the stream-gaging station Calaveras Creek near Elmen-dorf, Texas are presented. The location of flood-water-retarding structures and hydrologic instruments in the area are shown. The 9 structures provide capacity for temporary storage of 12,040 acre-feet of flood runoff from 37.1 of the 77.2-square-mile study area. The weighted-mean rainfall was 36.98 inches, or 134% of the 14-year (1954-68) average. The monthly-rainfall totals ranged from 0.96 inch in March to 7.99 inches in September. Mean daily discharge at the stream-gaging station was 25.1 cfs compared with the 14-year average of 10.7 cfs. Annual runoff at the stream gaging station was 18,220 acre-feet, or 4.42 inches. Three storm periods were selected for detailed computations. These computations include a detailed time breakdown of rainfall and discharge, hydrographs, and mass curves. The water in the reservoirs contained calcium and bicarbonate as the predominant ions. The dissolved solids ranged from 52 mg/liter to 165 mg/liter. The water in this basin should be satisfactory for domestic supply, industrial use, and irrigation. (Woodard-USGS)  
W71-03704

#### QUALITY OF SURFACE WATERS OF THE UNITED STATES, 1965: PARTS 5 AND 6. HUDSON BAY AND UPPER MISSISSIPPI RIVER BASINS, AND MISSOURI RIVER BASIN.

Geological Survey, Washington, D.C.

For sale by Superintendent of Documents, US Government Printing Office, Wash, DC 20402 - Price \$2.50. Geological Survey Water-Supply Paper 1963, 1970. 548 p, 1 fig, 32 ref.

Descriptors: \*Water quality, \*Surface waters, \*Missouri River, \*Mississippi River basin, \*Water analysis, \*Data collections, Chemical analysis, Sediment transport, Water temperature, Sediment load, Particle size, Water properties, Water chemistry.

Identifiers: \*North-central United States.

During the water year ending September 30, 1965, the U. S. Geological Survey maintained 181 stations on 121 streams that drain into the Hudson Bay, Upper Mississippi River, and Missouri River from the states of Colorado, Illinois, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wisconsin and Wyoming. Data of chemical analyses, suspended sediment, and temperature of the surface waters are tabulated. Samples were collected daily or monthly at 143 of these locations for chemical-quality studies. Samples also were collected less frequently at many other points. Water temperatures were measured continuously at 9 stations and daily at 69 stations. Quantities of suspended sediment are reported for 44 stations. Sediment samples were collected one or more times daily at most stations, depending on the rate of flow and change in stage of the stream. Particle-size distributions of sediments were determined at 63 of the stations. (Woodard-USGS)  
W71-03707

#### STREAMFLOW RECORDS OF THE SNOWY MOUNTAINS REGION, AUSTRALIA TO 1965 - VOLUME 1: GENERAL INFORMATION AND MURRUMBIDGEE RIVER BASIN.

Snowy Mountains Hydro-Electric Authority, Cooma (Australia).

Snowy Mountains Hydro-Electric Authority Data Report, April 1970. 280 p, 8 fig, 2 maps, 2 tab, 100 ref.

Descriptors: \*Hydrologic data, \*Surface waters, \*Streamflow, \*Flow measurement, \*Gaging stations, Data collections, Discharge measurement, Average flow, Peak discharge, Stream gages, Meteorology.

Identifiers: \*Murrumbidgee River Basin (Australia), \*Streamflow basic data, \*Australia.

Streamflow data for the Murrumbidgee River Basin, Australia, are presented as volume 1 of three volumes of streamflow records (to 1965) from the Snowy Mountains Region. Streamflow records which could be used for the investigation of the Snowy Mountains scheme began with one station in 1890 and reached a maximum of 122 stations in 1958. This was supplemented by a comprehensive meteorological network to provide detailed information on the variability of runoff, storm rainfalls, snow depth, evaporation and other meteorological elements. The records for each gaging station are presented in three forms: (1) A summary page which contains geographical data, a history of the station, and a summary of its records; (2) Monthly records which contain the runoff volumes of each month of record and the maximum instantaneous discharges observed in each month; and (3) Daily records which contain the daily average discharge. (See also W71-03709 and W71-03710). (Woodard-USGS)  
W71-03708

#### STREAMFLOW RECORDS OF THE SNOWY MOUNTAINS REGION, AUSTRALIA TO 1965 - VOLUME 2: UPPER MURRAY RIVER BASIN.

Snowy Mountains Hydro-Electric Authority, Cooma (Australia).

Snowy Mountains Hydro-Electric Authority Data Report, April 1970. 365 p, 1 map.

Descriptors: \*Hydrologic data, \*Surface waters, \*Streamflow, \*Flow measurement, \*Gaging stations, Data collections, Discharge measurement, Average flow, Peak discharge, Stream gages, Meteorology.

Identifiers: \*Upper Murray River Basin (Australia), \*Streamflow basic data, \*Australia.

Streamflow data for the Upper Murray River Basin, Australia are presented as volume 2 of three volumes of streamflow records (to 1965) from the Snowy Mountains Region. Streamflow records which could be used for the investigation of the Snowy Mountains scheme began with one station in 1890 and reached a maximum of 122 stations in 1958. This was supplemented by a comprehensive meteorological network to provide detailed information on the variability of runoff, storm rainfalls, snow depth, evaporation and other meteorological elements. The records for each gaging station are presented in three forms: (1) A summary page which contains geographical data, a history of the station, and a summary of its records; (2) Monthly records which contain the runoff volumes of each month of record and the maximum instantaneous discharges observed in each month; and (3) Daily records which contain the daily average discharge. (See also W71-03708). (Woodard-USGS)  
W71-03709

#### STREAMFLOW RECORDS OF THE SNOWY MOUNTAINS REGION, AUSTRALIA TO 1965 - VOLUME 3: SNOWY RIVER BASIN.

Snowy Mountains Hydro-Electric Authority, Cooma (Australia).

Snowy Mountains Hydro-Electric Authority Data Report, April 1970. 322 p, 1 map.

Descriptors: \*Hydrologic data, \*Surface waters, \*Streamflow, \*Flow measurement, \*Gaging stations, \*Australia, Data collection, Discharge measurement, Average flow, Peak discharge, Stream gages, Meteorology.

Identifiers: \*Snowy River Basin (Australia), \*Streamflow basic data, \*Australia.

Streamflow data for the Snowy River Basin, Australia are presented as volume 3 of three volumes of streamflow records (to 1965) from the Snowy Mountains Region. Streamflow records which could be used for the investigation of the Snowy

Mountains scheme began with one station in 1890 and reached a maximum of 122 stations in 1958. This was supplemented by a comprehensive meteorological network to provide detailed information on the variability of runoff, storm rainfalls, snow depth, evaporation and other meteorological elements. The records for each gaging station are presented in three forms: (1) A summary page which contains geographical data, a history of the station, and a summary of its records; (2) Monthly records which contain the runoff volumes of each month of record and the maximum instantaneous discharges observed in each month; and (3) Daily records which contain the daily average discharge. (See W71-03708). (Woodard-USGS)  
W71-03710

#### THE GENETIC METHOD OF COMPUTATION OF FLOOD CAUSED BY STORM RAINFALLS IN SMALL CATCHMENT AREAS IN THE ABSENCE OF HYDROLOGICAL DATA, Wyzsza Szkoła Rolnicza, Wrocław (Poland).

For primary bibliographic entry see Field 02A.

W71-03716

#### METHOD OF COMPUTING RAINFALL FLOODS CHARACTERISTICS,

Kazakhskii Nauchno-Issledovatel'skii Gidrometeorologicheskii Institut, Alma-Ata (USSR).

For primary bibliographic entry see Field 02A.  
W71-03717

#### CONTRIBUTION TO THE METHODOLOGY OF EVALUATION OF MAXIMUM FLOOD FLOW WHEN AVAILABLE DATA ARE INSUFFICIENT (FRENCH),

Office de la Recherche Scientifique et Technique Outre-Mer, Paris (France).

For primary bibliographic entry see Field 02A.  
W71-03718

#### EXPERIMENTAL STUDY OF RAINFALL RUNOFF,

Gidrometeorologicheskii Institut, Odessa (USSR).

For primary bibliographic entry see Field 02A.

W71-03719

#### RAINFALL FLOOD FORMATION THEORY AND METHODS OF RAINFALL FLOOD COMPUTATION,

Gidrometeorologicheskii Institut, Odessa (USSR).

For primary bibliographic entry see Field 02A.  
W71-03720

#### ESTIMATION OF DESIGN FLOOD DISCHARGES ESPECIALLY FOR RIVER VALLEY PROJECT IN INDIA,

Ministry of Irrigation and Power (India); and Central Water and Power Commission, New Delhi (India).

For primary bibliographic entry see Field 02E.  
W71-03721

#### ON PRINCIPLES OF ESTIMATION METHODS OF MAXIMUM DISCHARGE,

State Hydrological Inst., Leningrad (USSR).

For primary bibliographic entry see Field 02E.  
W71-03722

#### DETERMINATION OF MAXIMUM POSSIBLE FLOOD FLOW USING THE UNIT HYDROGRAPH AND THE 'MAXIMUM DURATION INTENSITY' CURVE (FRENCH),

Université Federale du Cameroun, Yaoundé.

For primary bibliographic entry see Field 02E.

W71-03723

## Field 07—RESOURCES DATA

### Group 7C—Evaluation, Processing and Publication

**SOLUTION OF THE UNSTEADY FLOW EQUATIONS AND ITS USE IN MODELING THE SURFACE RUNOFF PROCESS,**  
Utah Water Research Lab., Logan.  
For primary bibliographic entry see Field 02E.  
W71-03776

**DIGITAL SYSTEMS FOR ON-SITE DATA COLLECTIONS FOR WATER QUALITY ANALYSIS,**  
Arkansas Univ., Fayetteville. Water Resources Research Center.  
For primary bibliographic entry see Field 05A.  
W71-03782

## 08. ENGINEERING WORKS

### 8A. Structures

**NEW MINE SEALING TECHNIQUES FOR WATER POLLUTION ABATEMENT.**  
Halliburton Co., Duncan, Okla.  
For primary bibliographic entry see Field 05G.  
W71-03456

**EROSION CONTROL ON AIR FORCE BASES,**  
Water Resources Engineers, Inc., Walnut Creek, Calif.  
For primary bibliographic entry see Field 02J.  
W71-03530

**BRIDGE DESIGN CONSIDERING SCOUR AND RISK,**  
Arizona Univ., Tucson; and Bureau of Public Roads, Washington, D.C.  
E. M. Laursen.

Proc Amer Soc Civ Eng, Transp Eng J ASCE, Vol 96, No TE2, p 149-164, May 1970. 16 p, 11 fig, 5 tab, 4 ref, 2 append.

Descriptors: \*Bridges, \*Piers, Abutments, \*Erosion, Design, Rivers, \*Bridge design, \*Bridge piers, \*Scour, Economic feasibility, Maximum probable flood, Foundation failure, Pile foundations, Flood forecasting.

The conclusion of a simple economic analysis is the construction of a bridge foundation so designed that the bridge is safe from scour occurring in the maximum probable flood. Cases of pier scour alone and abutment scour alone are analyzed, assuming reasonable costs of bridge and foundation piles, flood magnitude-frequency relations plotting as straight lines on log-normal paper, the risk of loss during the life of the bridge, and scour prediction relations somewhat verified in the field. (USBR)  
W71-03739

**CONTROL MEASUREMENTS ON DAMS. RAPID SURVEY METHODS,**  
Electro-Watt Engineering Services Ltd., Zurich (Switzerland).  
R. Sinniger.

Tenth International Congress on Large Dams, Montreal, Can, Vol 3, Quest No 38, p 7-18, June 1970. 12 p, 6 fig.

Descriptors: \*Dams, \*Instrumentation, Measurement, Damsites, \*Concrete, Dams, Equipment, \*Earth dams, Control, Settlement, Tiltmeters, \*Surveys, Measuring instruments, Dam foundations.

The tendency to build larger dams at sites with complex and often difficult foundation conditions has produced the need for increased expenditure on the surveillance and checking of the completed structure. The measurements obtained, as well as indicating the security of the structure, can be used to determine the behavior of the construction materials. Many measuring instruments are necessary because a single instrument can only record the change in condition of a small portion of the

dam. Assessing a large quantity of survey data to judge the behavior of the whole structure is necessary. Only the geodetic control of selected points, and in the case of concrete dams, the use of pendulums, allow the overall behavior of a dam to be checked in a relatively short time. For dams situated at high altitudes, it is not possible to make regular geodetic surveys throughout the whole year, and means were sought for making rapid but accurate partial surveys at certain times of the year. Three such methods dictated by local conditions are discussed, and details are given of the results obtained. (USBR)  
W71-03742

### SAFETY AND BEHAVIOUR OF CONCRETE DAMS. METHODS OF OBSERVATIONS AND ORGANIZATION,

A. U. Huggenberger.  
Tenth International Congress on Large Dams, Montreal, Can, Vol 3, Quest No 38, p 169-178, June 1970. 10 p, 1 tab.

Descriptors: \*Dams, Concretes, Safety factors, Design, \*Concrete dams, Control, Model tests, Instrumentation, Measurement, Dam foundations, Dam failure, \*Safety, Measuring instruments.

The methods of computation, the tests on models, the constant surveillance with adapted measurement instruments and procedures, the strict surveys of concrete, the observations of foundations, abutments, and basin slopes, the appropriate organization of all observations, and the critical judgment of all results enable the safety of a concrete dam to be judged and steps to be taken to avoid serious damage or the complete destruction of the structure, with its disastrous consequences. (USBR)  
W71-03743

### SOME UNUSUAL ASPECTS OF DAM SAFETY STUDIES IN WESTERN UNITED STATES,

Bechtel Corp., San Francisco, Calif.

K. V. Taylor.  
10th International Congress on Large Dams, Montreal, Can, Vol 3, Quest No 38, p 465-487, June 1970. 23 p, 4 fig, 1 ref.

Descriptors: \*Dams, \*Safety, Earth dams, Concrete dams, Rockfill dams, Dam failure, Inspection, Hazards, Legal aspects, Dam foundations, Seepage, Deterioration, Spillway design flood, \*Investigations.

Identifiers: Western United States, Deficiencies, Dam stability, Remedial treatment.

The shifting population distribution toward the west places greater emphasis in this area on the necessity for close inspection and safety investigation of dams, and particularly older dams, many of which were designed and constructed to standards that would be unacceptable now. The principal deficiencies generally are: inadequate spillways; insufficient stability if subjected to major seismic forces; foundation problems caused by extensive faulting, weak bedrocks, and loss of strength of materials when saturated; seepage and drainage problems; and poor quality construction materials, particularly concrete aggregates. Several examples of such conditions are discussed, findings from safety investigations are outlined, and remedial measures required to enhance the safety of the structures are described. The average cost of conducting a safety investigation is estimated to be about \$15,000 to \$20,000 for engineering, and a similar amount for field exploration. Some legal aspects of safety investigations are mentioned. (USBR)  
W71-03753

### BASIC CONSIDERATIONS OF WELL DESIGN,

Bureau of Reclamation, Denver, Colo.

T. Ahrens.  
Water Well Journal, Vol 24, No 4, 5, 6, 8, p 45-50, 49-51, 47-51, 25-37, Apr, May, June, Aug, 1970. 17 p, 1 tab, 32 ref.

Descriptors: \*Water wells, Design, Construction, Aquifers, Wells, Well screens, Well casings, Testing, \*Drilling, Drilling equipment, Grouting, Shear stress, Corrosion, Groundwater, Economics, Efficiencies.

Identifiers: \*Well logging, \*Well yield, Gravel packs, Compressive stress, Sulfate-reducing bacteria.

Water well design is concerned with efficient use of the aquifer, reasonable life expectancy, and low operation and maintenance costs in conjunction with the purpose of the installation and the economics involved. Wells of 150 gpm or more in unconsolidated aquifers are discussed. Much information presented is equally applicable to smaller wells and to wells in consolidated formations. Pilot holes, drilling specifications, well hydraulics, well casings, grouting, well screen slot sizes and materials, gravel packs, approaches to well development, and well testing are discussed. The 100% efficient well will never be constructed, but there is no reason to accept wells with a specific capacity of 10 gpm when the aquifer is capable of 20 gpm. Experience shows that more efficient wells, while having a higher initial cost, are not only less expensive to operate but are less subject to deterioration and failure, and have a longer effective life. (USBR)  
W71-03758

### FOUNDATION INSTRUMENTATION AT PLEASANT VALLEY PUMPING PLANT,

Bureau of Reclamation, Denver, Colo. Office of Chief Engineer.

For primary bibliographic entry see Field 08D.

W71-03767

### ROTARIES TO PLAY BIG ROLE IN FUTURE ROCK - DRILLING METHODS,

Christensen Diamond Products Co., Salt Lake City, Utah.

D. S. Rowley.

Oil and Gas Journal, Vol 68, No 44, p 82-87, November 2, 1970. 5 fig, 5 tab, 10 ref.

Descriptors: \*Drilling, \*Rotary drilling, Drilling equipment, Oil industry.

Identifiers: \*Rotary system performance, \*Drilling rates, Footage per bit ratios, Drilling cost, Depth capacity, Power-transmission capacity, Drilling-rate potential, Tensile stress, Hoop stress, Shear.

Because rotary drilling rates continue to increase, rotary is likely to retain its place of leadership among drilling methods for the predictable future, possibly evolving from the conventional jet-rotary drilling system to a rotary-erosion drilling system. Improvements in rotary performance provide a moving target for the developers of novel drills. Rotary-drilling rates will rise as drill pipe with higher tensile yield strength is applied. The increased yield strength permits greater combined pipe stress, meaning more hydraulic power, more rotary power, and greater hook loads. From development work on diamond bits, it is known that competition and drilling economics both provide compelling incentives in the development of improved tools, methods, and materials that can consistently provide better field performance at reduced cost. Average drilling rates climb; footage per bit increases; drilling cost per foot decreases. These trends are the marks of the moving target, and rotary drilling performance still does not appear to be reaching any real performance plateau. For rotary drilling, it seems that stronger drill pipe will be required and will be used; pump-pressure capacity and power will increase; bit pressure drop and hydraulic power consumption will increase substantially; and rotary power consumption capacity of bits and their coupling efficiency to the rock must increase. (Campbell-NWWA)  
W71-03830

### FISHING IS MORE ART THAN SCIENCE,

Forest Oil Corp., Midland, Tex.

For primary bibliographic entry see Field 04B.

W71-03832

**KEYS TO MILLING, WASHOVER OPERATIONS,**  
Signal Oil and Gas Co., Midland, Tex.  
For primary bibliographic entry see Field 04B.  
W71-03833

**DESIGN AND RATING OF WELLS AND WELL FIELDS,**  
Michigan State Geological Survey, Lansing, Dept. of Conservation.  
For primary bibliographic entry see Field 04B.  
W71-03836

**PRODUCTION ANALYSIS OF ARTESIAN WELLS,**  
Purdue Univ., Lafayette, Ind.  
For primary bibliographic entry see Field 04B.  
W71-03837

**DEVELOPMENT OF REVERSE-ROTARY WELLS,**  
Winter-Weiss Co., Denver, Colo.; and Lauman (C.W.), Bethpage, N.Y.  
O. C. Gossett, and H. Lauman.  
Water Well Journal, Vol 13, No 3, p 48-49, March 1959. 3 fig.

Descriptors: \*Drilling, \*Rotary drilling, Water wells, Drilling equipment, Irrigation wells, Recharge wells, Municipal wells.  
Identifiers: \*Reverse-rotary drilling, \*High productivity application, \*Completion, Major population centers, Gravel packing.

Completion methods used in reverse-rotary wells are different only in that they must be consistent with the requirements of a large-diameter installation. As in any other type of wells, the method used in completing depends upon formation characteristics, water level conditions, and the end use of the well. The cleaning and development requirements of the reverse-rotary well are ordinarily minimal since it is seldom necessary to use mud additives for drilling. The use of reverse-rotary in construction of wells for municipal and commercial purposes is prevalent in major population centers throughout the U.S. Irrigation wells drilled by reverse circulation are in wide use in Midwestern United States. The terminal moraine offers many problems to the well driller because of unstratified mixture of clays, sands and gravel. The use of reverse-rotary drilling equipment solves many of those problems. (Campbell-NWWA)  
W71-03844

**DEVELOPMENT OF WELLS WITH CABLE TOOLS,**  
Bucyrus-Erie Co., South Milwaukee, Wis.  
R. W. Gordon.  
Water Well Journal, Vol 13, No 2, p 36-39, February 1959. 4 fig, 2 tab.

Descriptors: \*Drilling, \*Water wells, Drilling equipment.  
Identifiers: \*Cable tool drilling, Rock wells, Gravel wells, \*Development methods, Backwash completion, Surfing, Screened wells, Compressed air development.

The cable tool method lends itself to development procedures with more chances of success than by any other method of similar expense. Cable tool drilling normally does not include the use of mud or additives and aquifers are less likely to be made impervious to any degree. A cable tool well finished in bed rock is quite often improved by simply pumping. This cleans out the fines and cuttings which may have become lodged in the formation by drilling action. Some rock wells can be further developed by the use of a surge pressure block. A well can be developed by two main methods—surfing or compressed air. These are two types of surge plunger with variations ranging from weighted bailers with ring washers to rope-wound drill stems. Two general methods for developing wells with compressed air are (1) backwashing and (2) open

well surging. The principle of backwashing is to force water out of the well through the screen and into the formation by compressed air. Open well surging with compressed air is capable of more vigorous application than the backwashing method. (Campbell-NWWA)  
W71-03845

**REVERT CUTS COSTS AND MAKES BETTER WELLS,**  
Universal Oil Products Co., St. Paul, Minn. Johnson Div.  
F. F. Zdenek.  
UOP Johnson Drillers Journal, Vol 41, No 6, p 1-3, November-December 1969. 3 fig, 2 ref.

Descriptors: \*Drilling fluids, \*Water wells, Rotary drilling.  
Identifiers: \*Revert, \*Bentonite mud, Drilling efficiency.

Revert is a food-grade, organic material which makes a bright blue drilling fluid when mixed with water at a ratio of about 6 pounds per 100 gallons. After a certain period of time, the fluid reverts to the viscosity of water through enzymatic action. Being a low solid, self-destroying fluid, revert does not contaminate water-bearing sands with clay particles and can be removed completely from the well during development. When it is used as a drilling fluid, water wells have significantly higher yields than those drilled with conventional drilling mud. It reduces friction in the mud-circulating system. This, together with other characteristics, can mean cost savings in the overall drilling operation. Revert makes it possible to drill more holes faster, because it can reduce friction losses in the circulating system by as much as 40%. Penetration rates are increased, so larger, deeper holes can be drilled faster and cheaper. A few case histories are described. (Campbell-NWWA)  
W71-03846

**REVERSE ROTARY WELL CONSTRUCTION,**  
Illinois State Water Survey, Urbana.  
Robert T. Sasman.  
Public Works, Vol 88, No 4, p 117-118, April 1957.

Descriptors: \*Drilling, \*Rotary drilling, Water wells, Drilling equipment, Municipal wells, Illinois.  
Identifiers: \*Reverse-rotary drilling, High water productivity applications, Large-diameter wells, Gravel packing.

The construction, drilling and testing of a large diameter water well in Urbana, Illinois is discussed. Well was drilled using reverse hydraulic rotary method which requires a large volume of water to circulate between the supply pit and down the hole outside the drill stem. Water and drill cuttings are returned to surface by suction through drill stem which is one of the early successful attempts in using the reverse circulation method. (Campbell-NWWA)  
W71-03847

**CEMENTING WATER WELLS,**  
Halliburton Oil Well Cement Co., Houston, Tex.  
B. D. Brown.  
Public Works, Vol 90, No 9, p 99-100, September 1959. 2 fig.

Descriptors: \*Cements, \*Water wells, Casings, Construction equipment, Texas, Oil industry.  
Identifiers: \*Cementing water wells, \*Isolation of producing zones, Yield stimulation, Protection of casing, Bentonite.

This article discusses the techniques and materials which will aid in obtaining maximum control of isolating the producing zones. Isolation is very desirable to protect water-bearing formations from contamination of less desirable strata or from the surface. The use of cementitious materials will provide the most effective means of obtaining this

isolation, will permit techniques of stimulations requiring hydraulic pressure and fluids, and will help to protect casing against corrosive waters. The types of materials used to cement casings are many, all of which permit dry blending of several additives to meet specific well conditions. A new tool developed for the petroleum industry incorporates features which are compatible for water well completions. In operation of this tool, a special plug is dropped from the surface and, through application of pump pressure, sets the sealing element and opens circulating ports. Cement material is mixed and pumped into the casing, through the circulating ports and above the sealing element. The top cementing plug seats on a special sleeve and through the application of pressure closes the circulating ports. Continued application of pressure shears the pins permitting plugs and sleeve to be pumped out of tool which thereby eliminates a drilling-out operation. (Campbell-NWWA)  
W71-03848

## 8B. Hydraulics

**ASYMPTOTIC NONLINEAR WAVE MOTION OF A VISCOUS FLUID IN AN INCLINED CHANNEL OF ARBITRARY CROSS SECTION,**  
Wisconsin Univ., Madison. Mathematics Research Center.

M. C. Shen, and S. M. Shih.

Available from NTIS as AD-715 958, \$3.00 in paper copy, \$0.95 in microfiche. MRC Summary Technical Report No 1047, February 1970. 30 p, 2 fig, 18 ref. OWRR Project A-037-WIS (1); and US Army, Contract No DÄ-31-124-ARO-D-462.

Descriptors: \*Wave action (Water), \*Channel flow, \*Surface tension, \*Dimensional analysis, \*Viscosity, Flow.

Identifiers: Tractable asymptotic theory, Viscous fluid, Linear elliptic, Three dimensional, Multiple-parameter.

A tractable asymptotic theory is achieved for the study of three-dimensional nonlinear wave motion of an incompressible, viscous fluid with surface tension in an inclined channel of arbitrary cross section. The method developed here is based upon a multiple-parameter singular perturbation scheme within the framework of long-wave approximation. The nonlinear problem is reduced to a sequence of linear elliptic mixed boundary-value problems, which can be solved by means of standard methods. Their solutions are then used to determine the wave speed and evolution equations governing the nonlinear wave motion. The results obtained give a quantitative description of a three-dimensional bore structure in an inclined channel of arbitrary cross section, and critical Reynolds number is also defined as a criterion for the instability of the wave motion.  
W71-03309

**A STATISTICAL MODEL TO PREDICT THE TRANSIT CAPACITY OF SEA-LEVEL CANALS,**  
Army Engineer Waterways Experiment Station, Vicksburg, Miss.

B. G. Stinson, J. W. Brown, and J. Harrison.

Sponsored by Atlantic-Pacific Interceanic Canal Study Commission. U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper H-69-12, December 1969. 19 p, 3 fig, 2 tab, 19 ref.

Descriptors: \*Mathematical models, \*Canals, Navigation, Ships.  
Identifiers: \*Statistical models, \*Sea-level canals, \*Transit capacities (Waterways).

The derivation and application of a statistical model in the form of an algebraic equation which predicts yearly capacities of sea-level canals are presented in this report. The equation considers only the following significant variables: canal geometry, ship mix, ship stopping distances, length

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and number of convoys, desired maximum waiting time, and overall canal efficiency (to predict transiting at less than maximum capacity). A simple algebraic representation is particularly useful because it can be used for preliminary canal transit studies without the need for either sophisticated mathematics or digital computer facilities. After narrowing the number of technically and economically feasible alternatives with the canal transit equation, the remaining alternatives can be studied in more detail by other means. Because of time limitations on the study, the canal transit equation has not been tested against either known solutions or solutions given by the digital computer simulation derived as part of this study and described in U. S. Army Engineer Waterways Experiment Station Miscellaneous Paper H-69-10. (Stinson-WES) W71-03319

#### BOUNDARY EFFECTS OF GRADED ROUGHNESS ELEMENTS IN TWO-DIMENSIONAL FLOW IN OPEN CHANNELS, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

B. J. Brown.

Sponsored by Assistant Secretary of the Army (R and D), Department of the Army, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper H-70-6, May 1970. 5 p, 1 fig, 2 pl, 22 tab.

Descriptors: \*Open channel flow, \*Roughness (Hydraulic), Riprap, \*Bank protection.

Identifiers: \*Boundary effects, \*Two-dimensional flow.

Tests were made on crushed graded limestone simulating riprap protection in two-dimensional flow in a 48-ft-long tilting flume. Three stone gradations involving different stone size ranges were tested. The results indicate that the root-mean-square of the surface protrusions is a suitable parameter for defining surface effects of densely spaced graded roughness elements such as quarry riprap. The average velocity can be expressed by an equation. (Brown-WES) W71-03323

#### TIDAL PRISM MEASUREMENTS AT MOUTH OF COLUMBIA RIVER; HYDRAULIC MODEL INVESTIGATION, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

F. A. Herrmann.

Sponsored by U. S. Army Engineer District, Portland, Oregon. U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper H-70-3, June 1970. 4 p, 36 plates.

Descriptors: \*Estuaries, \*Tides, \*Columbia River, \*Hydraulic models, Oregon.

Identifiers: \*Tidal prisms.

Measurements of tidal prism at the mouth of the Columbia River were made in the existing model of the Columbia River estuary. The measurements were made for mean and spring tide conditions and involved integration of systematic measurements of cross-sectional area, current velocity, and tidal elevations. (Herrmann-WES) W71-03324

#### INSIGHTS GAINED FROM RIVER SEDIMENTATION MODELS, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

For primary bibliographic entry see Field 02J.

W71-03325

#### EFFECTS OF PROPOSED ELIZABETH RIVER DIKE ON TIDES, CURRENTS, SALINITIES AND SHOALING; HYDRAULIC MODEL INVESTIGATION, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

R. A. Boland, and W. H. Bobb.

Sponsored by U. S. Army Engineer District, Norfolk, and Naval Facilities Engineering Command, Norfolk. U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper H-69-13, December 1969. 5 p, 4 tab, 13 photo, 17 plates.

Descriptors: \*Dikes, \*Tides, \*Currents (Water), \*Salinity, \*Shoals, \*Hydraulic models.

Identifiers: \*Elizabeth River.

Existing comprehensive fixed-bed model of James River was used to determine effects of the proposed Elizabeth River dike. Test results consist of measurements of tide heights, current velocities, salinities, and shoaling quantities. From these data it was concluded that the proposed dike had little effect on tides, currents, or salinities in the problem area. In the model, the major source of sediment moving to and depositing in the Elizabeth River channel was found to be the shallow-water area between the Craney Island disposal area and the Newport News Channel. If this area does, in fact, constitute the major source of Elizabeth River channel shoaling in the prototype, the annual shoaling rate in the channel will be greatly reduced by construction of the dike; and the shoaling in the slips will be increased slightly. It is recommended that consideration be given to radioisotope or other tracer techniques to determine the source of shoaling in the Elizabeth River channel, provided an analysis of benefits and costs indicates that construction of the dike would be economically feasible. (Boland-WES) W71-03326

#### WATERHAMMER ANALYSIS BY THE METHOD OF CHARACTERISTICS, Bologna Univ. (Italy).

G. Evangelisti.

L'Energia Elettrica, Vol 46, No 10, 11, 12, p 673-692, 759-771, 839-858, Oct/Nov/Dec 1969. 53 p, 64 fig, 155 ref.

Descriptors: \*Water hammer, Digital computers, Fluid mechanics, Fluid flow, \*Mathematical models, Fluid friction, Pipelines, Surge tanks, Flow diagrams, Computer programs, Bibliographies, Technology, Calculations, Hydraulics, Foreign research.

Identifiers: \*Method of characteristics, Italy, Boundary conditions, Water column separation, Acceleration (Mechanical).

Water hammer problems are analyzed by using the method of characteristics in the theoretical investigation and in the numerical computation. Disturbed flow is considered, allowing for compressibility and fluid friction; pipes are considered as having a section with elastic characteristics. Hydraulic and mechanical systems placed at the ends of each pipe are considered as extremity conditions. Mathematical models are established and solved by computer programs that divide the numerical procedure into elementary subprograms. A method is given for using the stored subprograms in various combinations for solving specific problems. A review of actual cases illustrates the proposed techniques and introduces some new formulation criteria. An extensive bibliography of 155 references on water hammer technology is given. (USBR) W71-03357

#### HEAD LOSSES IN WYES AND MANIFOLDS, British Columbia Univ., Vancouver.

E. Ruus.

Proc Amer Soc Civ Eng, J Hydraul Div, Vol 96, No HY3, p 593-608, Mar 1970. 16 p, 13 fig, 1 tab, 10 ref, 2 append.

Descriptors: \*Head loss, Hydraulic models, Hydraulics, Pipe bends, \*Pipe flow, Pipelines, Instrumentation, Manometers, Pressure head, Tie rods, Discharges, Foreign research, Test procedures, Analysis, Discharge measurement.

Identifiers: Test results, \*Manifolds, \*Wye branches, Bifurcations, Canada, Foreign testing, Accuracy, Velocity head.

Head loss coefficients are determined experimentally for symmetrical and unsymmetrical flow through 9 symmetrical conical and spherical wyes and manifolds. The diameters of the main and branch pipes are 5-1/4 in. and 3-3/4 in. The angle of bifurcation varies from 45 deg to 90 deg. The conical wyes and manifolds are tested with and without tie rods of 3/16, 3/8, 9/16, and 3/4 in. dia, placed in turn at the center of the wye. The diameters of the spheres of spherical wyes are 5.85 in. and 7.50 in. Head loss depends on the angle of bifurcation, the diameter of the tie rod or the sphere, and the ratio between discharges in the branch and main pipes. For symmetrical flow conditions, the head losses caused by wyes or manifolds with an angle of bifurcation not over 60 deg are less than 10% of the velocity head in the main pipe. Tie rods increase head losses and should be avoided. (USBR) W71-03359

#### GEOMETRIC STABILITY ANALYSIS OF AN ALLUVIAL RIVER, Corps of Engineers, Vicksburg, Miss. Potamology Section.

Brien R. Winkley, and Lamont G. Robbins.

In: Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ Water Resources Research Institute, p 75-102, 1970. 28 p, 2 tab, 12 chart, 9 ref. OWRR Project A-999-MISS (6).

Descriptors: \*Mississippi River, \*Channel morphology, \*Scour, \*Sediment transport, \*Channel improvement, River training, Flood control, Alluvial channels, Hydraulics, Channel erosion, Channel flow, Distribution patterns, Regime, Shape.

Identifiers: \*Fluvial hydraulics.

Geometric analysis of the Mississippi River shows that there is an optimum depth to which any stream will scour and that there is a specific spacing of bars and pools that is dependent on the discharge. Consequently, in any channel improvement project, the general alignment of the natural channel must be studied in order to determine the geometric relationships that need to be conserved. The bars must be locked into natural deposition areas, the widths must be controlled, and there must be smooth transitions from pools to crossings and back to pools in order for the improved channel to operate properly. (See also W71-03380). (Knapp-USGS) W71-03383

#### CONTROL OF SCOUR AT HYDRAULIC STRUCTURES, Army Engineer Waterways Experiment Station, Vicksburg, Miss. Hydraulics Div.

Thomas E. Murphy.

In: Proceedings Water Resources Conference, Mississippi State University, State College, April 14-15, 1970, published by Mississippi State Univ Water Resources Research Institute, p 103-115, 1970. 13 p, 9 fig. OWRR Project A-999-MISS (6).

Descriptors: \*Drops (Structures), \*Erosion control, \*Outlets, \*Stilling basins, \*Energy dissipation, Control structures, Turbulence, Turbulent flow, Scour, Alluvial channels.

Identifiers: \*Scour control.

Tests conducted at the U. S. Army Corps of Engineers Waterways Experiment Station demonstrate the advantages in providing for or performing a 'scour hole' in which flow can expand and dissipate its excess energy in turbulence rather than in a direct attack on the channel bottom and sides. Even a relatively small amount of expansion, preferably both vertically and horizontally, will greatly reduce the severity of the attack on the channel boundaries. This makes it possible to stabilize the channel with rock of an economical size and provides additional factors of safety against riprap failure and costly maintenance. (See also W71-03380). (Knapp-USGS) W71-03384

**NON-DARCY FLOW IN THE VICINITY OF WELLS,**  
New South Wales Univ., Kensington (Australia).  
School of Civil Engineering.  
For primary bibliographic entry see Field 02F.  
W71-03403

**THEORY AND APPRAISAL OF HYDRAULIC CONDITIONS IN WELLS,**  
Water Conservation and Irrigation Commission (Australia).  
C. F. Forbes.

In: Proceedings of Groundwater Symposium, New South Wales University, Manly Vale, Australia, August 28-29, 1969; New South Wales University Water Research Laboratory Report No 113, Paper No 3, p 28-49, April 1970. 22 p, 14 fig, 9 ref, 2 append.

Descriptors: \*Groundwater movement, \*Water wells, \*Withdrawal, \*Dupuit-Forchheimer theory, \*Drawdown, Well screens, Pumping, Water yield, Darcys law, Permeability.

Identifiers: \*Aquifer testing, \*Well testing, Well efficiency.

The use of the standard well tests is discussed in relation to drawdown prediction, determining the state of development, and studying suitability of design and construction. The presence of a nonlinear loss does not mean that a considerable linear well loss may not also be present. If linear well loss is compared with the aquifer loss between the well radius and the screen the effect of clogging can be readily observed. Part of enlightened well operation should include periodical step drawdown tests of short duration in order to assess deterioration of hydraulic condition. Well testing should also be employed for drawdown prediction and assessment of well efficiency. (See also W71-03401) (Knapp-USGS)  
W71-03404

**INTERNAL HYDRAULICS OF THERMAL DISCHARGE DIFFUSERS, A DISCUSSION,**  
Camp, Dresser and McKee, Boston, Mass.  
For primary bibliographic entry see Field 05D.  
W71-03461

**TURBULENT DIFFUSION AND ENTRAINMENT IN TWO-LAYER FLOW, A DISCUSSION,**  
Puerto Rico Univ., Mayaguez. Dept. of Civil Engineering.

Chin-Yih Kuo.  
Journal of the Waterways and Harbors Division, Proceedings of the ASCE, Vol 96, No WW4, Nov 1970, p 867-868. 1 fig, 1 ref.

Descriptors: \*Turbulent diffusion, \*Density stratification, Temperature Gradient, Turbulence, Reservoirs, Mixing.

Identifiers: \*Entrainment in two-layer flow, \*Desratification, Molecular entrainment.

The study was conducted primarily to seek new methods for the desratification of a reservoir with thermocline in order to prevent the deterioration of the bottom waters. In the paper a similar type of model explaining the mechanism of turbulent diffusion and entrainment was proposed. One conclusion is that this model can be used for laboratory observations without spending a long time on the prototype observations. Then a relation between the prototype and the model may be established to predict the desired field date. The external flow which is circulated by means of pumping may pass through a honeycomb or a porous wall, generates uniform flow fields in the two regions, and introduces a disturbance with its accompanying energy input. Two independent mixing processes are: (1) Fluid pumped from one region to another and blended; and (2) possible entrainment occurring across the density interface. It is said that the second method can be augmented by creating additional turbulent agitation at the interface, otherwise molecular entrainment would prevail. (Herrera-Vanderbilt)  
W71-03462

**HEATED SURFACE JET DISCHARGED INTO A FLOWING AMBIENT STREAM,**  
Vanderbilt Univ., Nashville, Tenn. Dept. of Environmental and Water Resources Engineering.  
For primary bibliographic entry see Field 05B.  
W71-03478

**SEDIMENT TRANSPORTATION MECHANICS: F. HYDRAULIC RELATIONS FOR ALLUVIAL STREAMS.**  
For primary bibliographic entry see Field 02J.  
W71-03667

**SEDIMENT TRANSPORTATION MECHANICS: Q. GENETIC CLASSIFICATION OF VALLEY SEDIMENT DEPOSITS.**  
For primary bibliographic entry see Field 02J.  
W71-03668

**EFFECT OF CHANNEL SHAPE ON GRADUALLY VARIED FLOW PROFILES,**  
Indian Inst. of Science, Bangalore. Dept. of Civil and Hydraulic Engineering.

Nagar S. Lakshmana Rao, and Kalambur Sridharan.  
ASCE Proceedings, Journal of the Hydraulics Division, Vol 97, No HY1, Paper 7798, p 55-64, January 1971. 10 p, 6 fig, 4 ref, append.

Descriptors: \*Open channel flow, \*Channel morphology, \*Flow profiles, Froude number, Flow rates, Regime, Canals, Alluvial channels, Stage-discharge relations.

Identifiers: Gradually varied flow.

Gradually varied flow profiles were analyzed with Froude number as a reference parameter. Generalized nondimensional varied flow profiles of the M and S types were computed for 56 channel shapes covering a wide range of rectangular, trapezoidal, triangular and parabolic channels. The computation results are presented in a summarized form taking the nondimensional profile length as the characteristic parameter. The effect of channel shape and Froude number on the varied flow profiles were studied. The figures presented can be used to obtain a rapid estimation of profile lengths for the channel shapes considered. (Knapp-USGS)  
W71-03669

**HYDRAULIC JUMP WITHIN GRADUALLY EXPANDING CHANNEL,**

Asian Inst. of Technology, Bangkok (Thailand). Dept. of Hydraulic Engineering, and Mindanao Development Authority (Philippines). Anat Arbabhirama, and Alejandro U. Abella.  
ASCE Proceedings, Journal of the Hydraulics Division, Vol 97, No HY1, Paper 7831, p 31-42, January 1971. 12 p, 9 fig, 4 ref, append.

Descriptors: \*Hydraulic Jump, \*Stilling basins, \*Hydraulic models, Open channel flow, Energy dissipation, Model studies, Mathematical models, Critical flow, Supercritical flow, Uniform flow.  
Identifiers: \*Hydraulic jump (Expanding channel).

Expanding channel jump is considered to behave as a section of a circular jump. Equations describing the characteristics of the expanding channel jump are derived, using observations conducted with 6 different angles of divergence. The experimental results showed a close agreement with theoretical solutions. The general equation developed for the jump, with proper evaluation of the side pressure force effect, describes the phenomenon regardless of the angle of divergence. An empirical expression for approximating the location of the jump within the transition was also developed. (Knapp-USGS)  
W71-03670

**A GENERAL NUMERICAL SOLUTION OF THE TWO-DIMENSIONAL DIFFUSION-CONVECTION EQUATION BY THE FINITE ELEMENT METHOD,**  
California Univ., Davis.

For primary bibliographic entry see Field 05B.

W71-03677

**NUMERICAL SOLUTION TO THE CONVECTIVE DIFFUSION EQUATION,**  
Battelle-Northwest, Richland, Wash.  
For primary bibliographic entry see Field 05B.  
W71-03690

**SOLUTION OF STEADY FLOW IN OPEN CHANNELS BY GRAPHS,**  
Tarbela Dam Project, Hazara (West Pakistan). Horace A. Johnson.

Civil Engineering, Vol 40, No 12, p 46-47, December 1970. 2 p, 2 fig.

Descriptors: \*Open channel flow, \*Steady flow, \*Stage-discharge relations, Channel morphology, Water measurement, Uniform flow, Mannings equation, Discharge measurement, Hydraulic radius, Roughness (Hydraulic).  
Identifiers: \*Trapezoidal open channels.

A method for computing uniform flow in trapezoidal channels through the use of two graphs is presented. The first graph gives the relationships among slope, flow, area, and velocity, for a section whose hydraulic radius equals 0.328 of the sq root of cross-sectional area. The value of the coefficient of friction in Manning's formula is also included among the relationships. The second graph gives the effect of change in channel side slope, bottom width, and depth of water. This graph also shows directly the most economic channel sections. (Knapp-USGS)  
W71-03702

**ESTIMATE OF TURBULENCE AND HYDRAULIC RESISTANCES DURING WAVE MOTION IN BODIES OF WATER,**  
For primary bibliographic entry see Field 02E.  
W71-03713

**SIMULATION OF HORIZONTAL TURBULENT DIFFUSION OF PARTICLES UNDER WAVES,**  
Louisiana State Univ., Baton Rouge. Coastal Studies Inst.  
For primary bibliographic entry see Field 02J.  
W71-03714

**THE EFFECT OF RAINFALL ON THE MECHANICS OF STEADY SPATIALLY VARIED SHEET FLOW ON A HYDRAULICALLY SMOOTH BOUNDARY,**  
Illinois Univ., Urbana. Dept. of Civil Engineering.  
For primary bibliographic entry see Field 02E.  
W71-03727

**HEAD LOSSES IN UNLINED ROCK TUNNELS,**  
Royal Inst. of Tech., Stockholm (Sweden). E. Reinius.  
Water Power, Vol 22, No 7/8, p 246-252, July/Aug 1970. 7 p, 16 fig, 5 tab, 18 ref.

Descriptors: \*Tunnels, Tunnel design, \*Tunnel hydraulics, \*Head loss, Tunneling, Tunnel construction, \*Roughness (Hydraulic), Bibliographies, Roughness coefficient, Test facilities, Friction, Laboratory tests, Rock mechanics, Discharges, Foreign research, Velocity, Fluid mechanics, Flow resistance, Hydraulics.  
Identifiers: Tunnel supports, Foreign testing, Sweden, Test results, Friction factors, Friction coefficient (Hyd.).

An investigation into the effects of roughness, driving direction, and reinforced portals on head loss in unlined hydraulic rock tunnels is described. The roughness of an unlined rock tunnel is influenced by: (1) the rock structure, (2) the advancing direction when excavating the tunnel, (3) the spacing of boreholes around the contour line of the tunnel, and (4) the blasting method. A test flume was used to study the influence of the orientation of the serrations and the wall surface roughness on the

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friction factor. The orientation of the serrations had a pronounced influence on the frictional resistance to flow. A tunnel excavated with the advancing direction against that of the flow has a lower head loss than a tunnel excavated in the flow direction. The influence of local reinforcing members at weak parts of the tunnel on resistance to flow was investigated. Three types of arch ribs were tested; an arch rib with bevelled corners gave a much smaller resistance to flow than an arch rib with sharp corners. For a certain cross-sectional area of the rib, a low, wide cross section gives less head loss than a high, narrow section. Has 18 references. (USBR)  
W71-03735

#### ENERGY DISSIPATION USING AIR INJECTION, Nottingham Univ. (England).

N. Hay.

Paper Hydraul Div Spec Conf, Univ Minn, Minneapolis, Aug 1970. 16 p, 7 fig, 10 ref, 2 append.

Descriptors: Kinetic energy, Energy, \*Energy dissipation, Hydraulics, Erosion, Hydraulic jump, \*Fluid mechanics, \*Aeration, Turbulence, Scour, Air entrainment, High pressure, Nappe, Foreign research, Model tests, \*Flow, \*Spillways, Air-water interfaces.

Identifiers: Great Britain.

A method of energy dissipation suitable for spillways in which air is introduced at the interface between the structure and the water nappe in the upper reaches of the structure is described and evaluated. Air induces turbulence in the stream, and kinetic energy is dissipated as it is generated. Literature on aerated flows supports the claims made for this method. Results of exploratory tests on a model spillway with air injection confirm that air injection reduces the energy at the foot of the spillway. A mean reduction nearing 50% was obtained in the model at an air concentration of 28%. The effect of air injection on the hydraulic jump at the foot of the spillway was beneficial because the jump was more stable and nearer to the foot of the spillway. (USBR)  
W71-03737

#### SOLUTION OF THE UNSTEADY FLOW EQUATIONS AND ITS USE IN MODELING THE SURFACE RUNOFF PROCESS, Utah Water Research Lab., Logan. For primary bibliographic entry see Field 02E. W71-03776

### 8C. Hydraulic Machinery

#### INCREASING THE ACCURACY OF DESIGN CALCULATIONS FOR CRITICAL SPEEDS OF THE ROTOR OF A HYDRAULIC UNIT BY THE METHOD OF INITIAL PARAMETERS, Bureau of Reclamation, Denver, Colo.

A. U. Bugov.

Translation of: Energomashinostroenie No 11, p 6-10, 1964. Available from NTIS as PB-193 623T, \$3.00 in paper copy, \$0.95 in microfiche. Bureau of Reclamation Translation No 692, August 1967. 18 p, 3 tab, 7 ref.

Descriptors: Rotation, Rotating components, Turbine runners, Rigidity, \*Vibrations, Mathematical analysis, Moments of inertia, \*Critical speed, Shafts, Machinery, Generators, Hydraulic turbines, Structural analysis, Structural behavior, Machines, Differential equations, Elasticity, Flexible foundations, Boundary values, Eccentric loading, Stress. Identifiers: Stators, \*Rotors, USSR, \*Machine design, Gyroscopic effects, Initial parameters method.

A method is presented for calculating critical speeds and constrained vibrations of the rotor of a hydraulic unit, considering the important structural parameters: elasticity of the support, gyroscopic

effect of mass settlement, and variable rigidity of the rotor along its length. Design calculations for modern powerful hydraulic units, such as at Krasnoiarsk Powerplant in the USSR, should include these factors. The rotor is considered as a vibrating string with 2 or 3 seated masses along it, dividing it into several parts. A. N. Krylov's method of initial parameters can be used for calculating shafts on an elastic foundation and critical speeds of rotors. The method is equivalent to substituting a system of differential equations with constant coefficients for different rotor parts for a differential equation with variable coefficients. The solution is written with the help of functions formed by normal fundamental systems. The initial parameters used values for weights, moments of inertia of the mass, and flexibility of the support. Examples of solutions are given and compared with results of calculations for critical speeds without considering these factors. If electronic computers are used, the functions can be calculated according to factorization formulas, containing 3 to 4 factors.  
W71-03526

#### THE ELECTRIC RESEARCH COUNCIL'S UNDERGROUND TRANSMISSION R AND D PROGRAM, Edison Electric Inst., New York.

G. E. Watkins.

Paper 2nd Annual Meeting, Int Elec Res Exch, Cannes, France, Sept 1970. 14 p, 1 tab.

Descriptors: Research and development, Electrical industries, Electric power, \*Extra high voltage, Electric cables, \*Transmission (Electrical), Technology, Capacitance, Electric insulation, Costs, Experimental data, Dielectrics, Cooling, Cryogenics, Superconductivity, Supercooling. Identifiers: \*High voltage, Electric Research Council, Pipe-type cables, Oil-filled cables, \*Underground transmission lines.

The problems and costs of putting high-voltage transmission systems underground are very different from those of the routine underground distribution of energy at low voltages. The extensive underground transmission R and D program of the Electric Research Council (ERC) seeks to perfect existing cable technology and to develop new ways of conveying large blocks of electric energy underground. Projects in progress are directed at the immediate demand for expanded underground operation. The longer-term projects, with potential for greater overall return, are designed to resolve the difficult and exacting problems associated with providing tomorrow's huge amounts of electrical power to our cities. The day of simple, reliable, and economic transmission of great blocks of power for long distances underground is still in the future. Under the program of the ERC, all segments of the electric utility industry in the U.S. are supporting the research and development efforts necessary to ensure that proper technology will be available for satisfying the vast future demands for underground power transmission. (USBR)  
W71-03733

#### ELECTRIC GENERATING PROSPECTS FOR NUCLEAR POWER, Massachusetts Inst. of Tech., Cambridge.

M. Benedict.

Inst Elec Electron Eng Spectrum, Vol 7, No 7, p 24-30, July 1970. 7 p, 6 fig, 5 tab.

Descriptors: \*Electric power production, \*Nuclear powerplants, Costs, Nuclear reactors, Thermal pollution, Efficiencies, Economics, Sodium, Electric powerplants, Electric power costs, Electric power. Identifiers: \*Nuclear power, Uranium, Plutonium, Fuel costs, \*Breeder reactors, Boiling-water reactors, Liquid-metal-cooled reactor.

In many sections of the U.S. thermal nuclear reactors compete with coal-fired electric plants, but if nuclear plants are to achieve full potential, developing an economical fast breeder reactor will be necessary. Most nuclear powerplants in the U.S.

are of the light-water variety. In many parts of the U.S. the plants are competitive with plants burning coal, but the electricity generated will be more costly in the future as uranium supplies are depleted. A promising possible answer to the cost problem is the fast-neutron reactor, which produces more fuel than it consumes. Such a plant should be a more efficient generator of electricity, producing less thermal pollution than a water-reactor plant. Breeding the fuel to make the fast reactors possible takes time; until more is known about the performance of such reactors, final judgment about the economic feasibility must continue to be withheld. (USBR)  
W71-03759

#### DRILLING-MUD LUBRICITY,

National Lead Co., Houston, Tex. Baroid Div. For primary bibliographic entry see Field 04B.  
W71-03831

#### CONSIDER LOST CIRCULATION IN WELL PLANNING, RIG SELECTION, Mobil Oil Corp., New Orleans, La.

For primary bibliographic entry see Field 04B.  
W71-03834

#### DIAMOND DRILLABILITY STUDIES,

Bureau of Mines, Minneapolis, Minn. Twin Cities Mining Research Center. William E. Bruce. Mines Magazine, Vol 58, No 3, p 26-27, March 1968.

Descriptors: \*Drilling, Core drilling, Rock mechanics, Mining, Oil industry, Drilling equipment.

Identifiers: \*Rock drillability, \*Diamond drilling, Compressive rock strength, Experimental drillability curves, Theoretical drillability curves, Groundwater industry.

Drilling studies conducted by the Bureau of Mines were aimed at establishing indices for predicting rock drillability based on the applied drilling forces, the physical properties of the rock, and associated parameters. The need for such indices is great. Drilling has always represented an important cost in the mining, petroleum and groundwater industries. Diamond drilling experiments were made in the field to test the validity of earlier laboratory findings. Field experiments were set up to collect data on a larger number and variety of rocks than those drilled in the laboratory and to determine the applicability of the laboratory results to actual field drilling situations. Previous laboratory drilling tests on nine different rocks suggested that compressive strength of rock could be a parameter for determining drillability. The results come from experiments involving 26 rock formations drilled in the field with a commercial diamond drill as well as with bits similar to those used in the laboratory test. (Campbell-NWWA)  
W71-03842

### 8D. Soil Mechanics

#### PRELIMINARY FINITE ELEMENT ANALYSIS, ATCHAFALAYA BASIN PROTECTION LEVEES TEST SECTION 3, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

J. B. Palmerton. Prepared for the President, Mississippi River Commission. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper S-69-53, December 1969. 26 p, 16 fig.

Descriptors: \*Levees, \*Foundation investigations, \*Clays, Soil properties, Mississippi. Identifiers: \*Atchafalaya River Basin, Finite element method.

A preliminary finite element analysis was made for a levee test section constructed within the Atchafalaya Basin Protection Levee system. The analysis was performed to explore the applicability of the finite element method for studying the behavior of levees placed on weak foundation materials. Three types of finite element analyses are described. The first, the secant method, approximates the stress-strain curves with elastic and plastic envelopes. The second, or tangent method, approximates the stress-strain curves with hyperbola. Analysis of incremental construction is possible with the tangent method. The third analysis is a linear elastic technique. The stresses and displacements predicted by the finite element method for various loading conditions during construction are also presented herein. (Palmerton-WES) W71-03328

**DESIGN OF OVERFLOW ROCKFILL DAMS,**  
Technische Hochschule, Munich (West Germany).  
F. Hartung, and H. Scheuerlein.  
Tenth International Congress on Large Dams, Montreal, Canada, Vol 1, Quest No 36, p 587-598, June 1970. 12 p, 6 fig, 6 ref.

Descriptors: \*Rockfill dams, Spillways, \*Spilling, Flood control, \*Overflow, Foreign research, Economics, Erosion, Laboratory tests, \*Dam design, Investigations, Turbulence, Boundary layers, Aeration, Turbulent flow, Roughness, Energy dissipation, Analytical techniques, Dams.  
Identifiers: German Federal Republic, Cost savings, Dam stability, Overtopping.

A large part of the total cost of a rockfill dam is required to provide flood control structures that are rarely used. Omitting the flood control structure would save building and operating costs. Such an arrangement would require permitting overflow of the dam, something not usually done with rockfill dams. This paper discusses flow over such dams. The economical advantage of overflow is compared with resulting disadvantages. The problem of highly accelerated flow down the surface of the dam is studied carefully. As a result of fundamental investigation s of flow in steep, rough, open channels, conducted at the Hydraulics Research Station of the Technical University of Munich at Obernach, Germany, an analytical method for approaching the problem is explained. Graphs are provided to simplify working with the equations. An example is presented to demonstrate the use of the graphs. (USBR) W71-03349

**THE APPLICATION OF BITUMEN FOR EARTH AND ROCKFILL DAMS,**  
Shell International Petroleum Co. Ltd., London (England); and Shell A. G., Hamburg (West Germany).  
W. Visser, E. Schoenian, and F. F. Poskitt.  
Tenth International Congress on Large Dams, Montreal, Canada, Vol 1, Quest No 36, p 631-659, June 1970. 29 p, 10 fig, 3 tab, 8 ref.

Descriptors: \*Earth dams, \*Rockfill dams, Bitumens, \*Cores, Rollers, \*Bituminous materials, Impervious materials, Uplift pressure, Asphalt, Dam design, Durability, Field tests, Revetments, Asphaltic concrete, Compaction equipment, Flexibility, Earth movements, Foreign design practices, Dams, Design criteria, Impervious membranes.  
Identifiers: Great Britain, \*Asphalt membranes, Dungonnell Dam, Northern Ireland, Construction methods.

Use of bitumen for earth and rockfill dams is becoming more established. By the end of 1968, 65 dams were sealed and protected with bituminous materials. Bitumen can be applied either as an external revetment or as an internal core. Use of bitumen in the design of the body of a dam is discussed. The properties of bituminous materials are described and advantages of flexibility are discussed. Attention is given to the design of the various mixes used and to the different application

techniques possible. The advantages and limitations of the various systems are discussed. Examples of recently constructed dams outside the United Kingdom are given, and the first bitumen-lined dam built in the United Kingdom, the Dungonnell Dam in Northern Ireland, is described. A list of dams constructed with bituminous materials is included. (USBR) W71-03350

#### PREVENTION OF CRACKING IN EARTH DAMS,

Bureau of Reclamation, Denver, Colo.  
F. C. Walker.

Tenth International Congress on Large Dams, Montreal, Canada, Vol 1, Quest No 36, p 361-370, June 1970. 10 p.

Descriptors: Dams, \*Earth dams, Dam design, \*Cracking, \*Cracks, Shear cracks, Dam foundations, Collapse, Safety, Corrections, Classification, Differential settlement, Stress, Slopes, Treatment, Displacements, Soil mechanics, Deformation, Remedies, Seepage.

Identifiers: Crack control, Construction control, Collapse phenomenon, Collapsing soils, Preventive maintenance, Slip planes.

Prevention of cracking in earth dams or correction of cracking that does occur requires a knowledge of the various conditions under which cracking happens. A classification system based on type of stress (tension, compression, or shear), surface slope (flat or steep), and stress-inducing agency (moisture change, temperature change, overloading, unloading, and differential loading) is examined for the circumstances under which cracking occurs. Seriousness of the effect of various types of cracking depends upon the critical engineering properties of the structure and foundation involved, and in consequence, whether prevention or corrective action is necessary. Preventative or corrective actions for each type listed in the classification system are described. Several case histories of rare or obscure situations that do not form a part of the usual experience of practicing engineers but that are of sufficient importance to require inclusion in any comprehensive consideration of the influence of cracking on earth dam design are presented. (USBR) W71-03351

#### PRECOMPRESSION FOR IMPROVING FOUNDATION SOILS,

Army Engineer Waterways Experiment Station, Vicksburg, Miss.  
S. J. Johnson.

Proc Amer Soc Civ Eng, J Soil Mech Found Div, Vol 96, No SM1, p 111-144, Jan 1970. 34 p, 27 fig, 2 tab, 52 ref, 3 append.

Descriptors: \*Preconsolidation, Embankments, Fills, \*Foundations, Soil stabilization, Settlement (Structural), \*Soil mechanics, Bibliographies, Loose soils, Design, Compression, Consolidation, Analytical techniques, Relief wells, Drains, Pore pressure, Pore water pressures, Safety factors.

Identifiers: \*Preloading, Compressible foundation, Compressible soils, Secondary consolidation, Surcharge.

Precompression of weak and compressible subsoils (with or without vertical sand drains to accelerate consolidation) to increase strength and decrease postconstruction settlements to tolerable amounts is discussed with references to uses and design procedures. Precompression is an effective way of eliminating, in advance of construction of structures or roads, primary consolidation and a portion of secondary compression that would otherwise occur. The amount of secondary compression that is avoided by precompression can be estimated reasonably well, and the surcharge fill can be designed to reduce the remaining secondary compression settlements to tolerable amounts. Design procedures for minimizing secondary compression effects are presented. (USBR) W71-03355

**FOUNDATION PRECOMPRESSION WITH VERTICLE SAND DRAINS,**  
Army Engineer Waterways Experiment Station, Vicksburg, Miss.  
S. J. Johnson.

Proc Amer Soc Civ Eng, J Soil Mech Found Div, Vol 96, No SM1, p 145-175, Jan 1970. 31 p, 30 fig, 2 tab, 44 ref, 2 append.

Descriptors: \*Preconsolidation, Compression, Consolidation, \*Sand drains, \*Vertical drains, Settlement (Structural), Drainage wells, Soil mechanics, Soil stabilization, \*Foundations, Loose soils, Drainage, Pore pressure, Relief wells, Foundation investigations, Design, Installation, Bibliographies.

Identifiers: \*Preloading, Compressible foundation, Surcharge, Secondary consolidation, Construction methods, Construction control.

Foundation precompression using preload fills combined with vertical sand drains to accelerate consolidation is described. Uses, design procedures, and possible effects of alternative methods for installing vertical sand drains are discussed. Vertical sand drains to accelerate consolidation are probably not required in soils containing continuous intermediate sand layers within the compressible stratum, but pressure-relief wells may be required to reduce excess pore-water pressures in the sand layers. Pressure-relief wells can be sand drains, free-flowing wellpoints, or conventional wells. Vertical sand drains will probably serve no purpose where design loadings will not exceed preconsolidation stresses. Field tests may be required in some stratified materials to evaluate the drainage efficacy of thin layers of pervious soils. The importance of designing for secondary compression effects is emphasized. (USBR) W71-03356

#### SOME LOADING TEST ON LONG PIPE PILES,

Golder, Brawner and Associates Ltd., Vancouver (British Columbia).

N. R. McCammon, and H. Q. Golder.  
Geotech, Vol 20, No 2, p 171-184, June 1970. 14 p, 10 fig, 3 tab, 7 ref.

Descriptors: Pile driving, \*Skin friction, \*Piles (Foundations), \*Pile friction, Cohesive soils, Cohesionless soils, \*Steel piles, Time, Pipes, \*Pile bearing capacities, Pile foundations.

Identifiers: Loading tests, \*Pile tests.

Two 24-in.-dia steel pipe piles were driven, one into granular and the other into cohesive soil, and test loaded to measure separately the skin friction and end-bearing components of the pile capacity. The paper describes the tests and presents the pertinent geotechnical properties of the subsoil at each test pile. The values of skin friction and end-bearing are reported. The pile driven into the cohesive soil was test loaded at various times after driving to determine any change in pile capacity with time. A FEATURE OF THE SITE WAS THE PRESENCE OF ARTESIAN WATER PRESSURES IN THE SOIL. The computed and measured values of pile capacity are compared. The skin friction and end-bearing values determined in the tests are used to estimate the bearing capacity of 60-in.-dia steel pipe piles to be driven at the site. (USBR) W71-03360

**THE DYNAMIC PENETRATION TEST: A STANDARD THAT IS NOT STANDARDIZED,**  
Illinois Univ., Urbana; La Plata Univ. (Argentina); and Sao Paulo Univ. (Brazil).  
H. O. Ireland, O. Moretto, and M. Vargas.  
Geotechnique, Vol 20, No 2, p 185-192, June 1970. 8 p, 4 fig, 4 ref.

Descriptors: Test procedures, Errors, Drilling, Sampling, Equipment, \*Penetration tests, Penetration resistance, Soil mechanics, Samplers, \*Soil tests, Soil dynamics, Foundation investigations.  
Identifiers: Dynamic tests, Site selection.

## Field 08—ENGINEERING WORKS

### Group 8D—Soil Mechanics

A description and a discussion of the technique of making the so-called standard penetration test used in North and South America are presented. Dynamic penetration tests such as the SPT are used for obtaining results that can be interpreted by engineers on a universal basis, but results are often a compromise because of details in the test procedure. The testers usually change the procedure of the test or the dimensions of the tools and continue to call it standard, apparently not realizing that changes cause variations in the penetration resistance number N. To consider the various implications of the method properly, a procedure for boring, sounding, and sampling is described; the SPT in its original form is described; as examples of variations, 2 modified and improved samplers and test procedures used in South America are mentioned; and the applicability and scope of the test are discussed. (USBR)  
W71-03361

**AN INVESTIGATION OF A CONE-PENETROMETER METHOD FOR THE DETERMINATION OF THE LIQUID LIMIT,**  
Road Research Lab., Crowthorne (England).  
P. T. Sherwood, and M. D. Ryley.  
Geotechnique, Vol 20, No 2, p 203-208, June 1970. 8 p, 5 fig, 3 tab, 13 ref.

Descriptors: Atterberg limits, Test procedures, Errors, Apparatus, \*Liquid limits, \*Penetrometers, \*Soil tests, Soil mechanics, Soil physical properties.  
Identifiers: Cone penetrometer test.

Recent investigations in the U K and in the U S show that results of the liquid limit test made with the Casagrande apparatus might give wide variations when results obtained by different laboratories are compared. The U S Road Research Laboratory has undertaken an examination of methods of reducing this variation. One possibility is that much of the variation is inherent in the Casagrande apparatus; one suggestion was that the Casagrande test should be replaced by one of the many cone penetrometer methods used in many countries. This paper describes an investigation to determine if one of the cone penetrometer methods would be an acceptable alternative to the Casagrande test. (USBR)  
W71-03362

**ON SUBSIDENCE OF LOESS SOILS OF THE UKRAINE,**  
Akademiya Nauk UkrSSR, Kiev. Instytut Geologichnykh Nauk.  
For primary bibliographic entry see Field 02F.  
W71-03406

**CONSIDERATION ABOUT THE COMPACTION MECHANISM OF STRATUM LYING AT THE DEEPER HORIZON IN TOKYO LOWLAND,**  
Hirosaki Univ. (Japan). Dept. of Pedagogics.  
For primary bibliographic entry see Field 02F.  
W71-03407

**SOME PROBLEMS OF TIME-SOIL COMPACTION IN PUMPING LIQUID FROM A BED,**  
All-Union Scientific Research Inst. of Hydrogeology and Engineering Geology, Moscow (USSR).  
For primary bibliographic entry see Field 02F.  
W71-03408

**LAND SUBSIDENCE, EARTH FISSURES AND GROUNDWATER WITHDRAWAL IN SOUTHCENTRAL ARIZONA, U.S.A.,**  
Geological Survey, Phoenix, Ariz.; and Geological Survey, Sacramento, Calif.  
For primary bibliographic entry see Field 02F.  
W71-03409

**LAND SUBSIDENCE AND AQUIFER-SYSTEM COMPACTION, SANTA CLARA VALLEY, CALIFORNIA, USA,**  
Geological Survey, Sacramento, Calif.

For primary bibliographic entry see Field 02F.  
W71-03410

**FIELD MEASUREMENT OF AQUIFER-SYSTEM COMPACTION, SAN JOAQUIN VALLEY, CALIFORNIA, USA,**  
Geological Survey, Sacramento, Calif.  
For primary bibliographic entry see Field 02F.  
W71-03411

**ON THE VARIATION OF ARTESIAN HEAD AND LAND-SURFACE SUBSIDENCE DUE TO GROUNDWATER WITHDRAWAL,**  
Saitama Univ., Urawa (Japan).  
For primary bibliographic entry see Field 02F.  
W71-03412

**SOME PROBLEMS AND RESULTS OF LABORATORY AND FIELD INVESTIGATIONS INTO ROCK MOVEMENTS CAUSED BY WATER MIGRATION IN LOOSE GRANULAR GROUNDS IN HUNGARY,**  
Hungarian Mining Research Inst., Budapest.  
For primary bibliographic entry see Field 02F.  
W71-03413

**INFLUENCE OF SUBSIDENCE ON BOTH SURFACE AND UNDERGROUND HYDROLOGY (FRENCH),**  
Ghent Rijksuniversiteit (Belgium).  
For primary bibliographic entry see Field 02F.  
W71-03414

**GEOLOGICAL AND GEOHYDROLOGICAL PROPERTIES OF THE LAND SUBSIDED AREAS-CASE OF THE NIIGATA LOW LAND,**  
Ministry of Agriculture and Forestry, Niigata (Japan). Hokuriku Regional Office.  
For primary bibliographic entry see Field 02F.  
W71-03415

**WATER BALANCE INVESTIGATION BASED UPON MEASUREMENTS OF LAND SUBSIDENCE CAUSED BY GROUNDWATER WITHDRAWAL,**  
District Water Authority, Pecs (Hungary).  
For primary bibliographic entry see Field 02F.  
W71-03416

**SIMULATION OF GROUNDWATER BALANCE AS A BASIS OF CONSIDERING LAND SUBSIDENCE IN THE KOTO DELTA, TOKYO,**  
Tokyo Univ. (Japan). Faculty of Science.  
For primary bibliographic entry see Field 02F.  
W71-03417

**GROUND SINKING IN SHIROISHI PLAIN, SAGA PREFECTURE,**  
Ministry of Agriculture and Forestry, Tokyo (Japan). Kanto Regional Office.  
For primary bibliographic entry see Field 02F.  
W71-03418

**EXPERIMENTS ON WATER INJECTION IN THE NIIGATA GAS FIELD,**  
Geological Survey of Japan, Tokyo.  
For primary bibliographic entry see Field 02F.  
W71-03419

**PREDICTION OF FUTURE SUBSIDENCE ALONG DELTA-MENDOTA AND SAN LUIS CANALS, WESTERN SAN JOAQUIN VALLEY, CALIFORNIA,**  
Bureau of Reclamation, Sacramento, Calif.  
For primary bibliographic entry see Field 02F.  
W71-03420

**AN EXAMPLE OF GROUND SUBSIDENCE ESTIMATION,**  
Public Works Research Inst., Tokyo (Japan).

For primary bibliographic entry see Field 02F.  
W71-03421

**ANALYTICAL METHODS FOR PREDICTING SUBSIDENCE,**  
Woodward-Clyde-Sherard and Associates, Oakland, Calif.  
For primary bibliographic entry see Field 02F.  
W71-03422

**A THEORETICAL APPROACH TO STRESS-STRAIN RELATIONS OF CLAYS,**  
Kyoto Univ. (Japan). Dept. of Civil Engineering.  
For primary bibliographic entry see Field 02F.  
W71-03423

**WATER PERMEABILITY AND PLASTIC INDEX OF SOILS,**  
Kanazawa Univ. (Japan). Dept. of Engineering.  
For primary bibliographic entry see Field 02F.  
W71-03424

**RELATIONSHIP OF CONSOLIDATION CHARACTERISTICS AND ATTERBERG LIMITS FOR SUBSIDING SEDIMENTS IN CENTRAL CALIFORNIA, U.S.A.,**  
Geological Survey, Denver, Colo. Water Resources Div.  
For primary bibliographic entry see Field 02F.  
W71-03425

**VISCO-ELASTIC THEORY OF THE DEFORMATION OF A CONFINED AQUIFER,**  
Kyoto Univ. (Japan). Disasters Prevention Research Inst.  
For primary bibliographic entry see Field 02F.  
W71-03426

**COMPRESSION OF THE PEAT-BOGS AFTER DRAINING,**  
For primary bibliographic entry see Field 02F.  
W71-03427

**SUBSIDENCE OF ORGANIC SOILS IN THE U.S.A.,**  
Agricultural Research Service, Athens, Ga. Soil and Water Conservation Research Div.  
For primary bibliographic entry see Field 02F.  
W71-03428

**PREDICTION OF HORIZONTAL MOVEMENTS DUE TO SUBSIDENCE OVER MINED AREAS,**  
California Univ., Los Angeles. Dept. of Engineering.  
For primary bibliographic entry see Field 02F.  
W71-03429

**ANALYSIS OF PILE GROUP BEHAVIOR,**  
Materials Research and Development, Inc., Oakland, Calif; Ohio State Univ., Columbus; and Dames and Moore, San Francisco, Calif.  
K. Nair, H. Gray, and N. C. Donovan.  
Amer Soc Test Mater Spec Tech Publ 444, p 118-159, 1969. 42 p, 16 fig, 6 tab, 13 ref, append.

Descriptors: \*Pile groups, Batter piles, Horizontal loads, Analysis, Deformation, Bending moments, Stress, Theoretical analysis, Settlement, \*Foundations, \*Pile foundations, Pile friction, Pile lateral loads, \*Piles (Foundations), Computer programming.  
Identifiers: Pile tests, Computer applications.

A procedure for the 3-dimensional analysis of pile groups subject to horizontal and vertical forces and moments which accounts for batter piles, the flexural resistance of the piles, and the lateral resistance of the surrounding soil is discussed. Because of the extensive amount of computational effort required to analyze a pile group, the analysis was programmed for a digital computer. Results obtained

from analyzing several pile group arrangements for various soil and loading conditions include the axial loads, moments, stresses, and deflections for individual piles and for group piles. Numerical results show the significant influence that the following factors have on loads that are introduced in the various individual piles: (1) the arrangement of the individual piles within the group, (2) the end condition as reflected by the connection between the pile cap and the piles, (3) the lateral resistance of the surrounding soil, and (4) the flexural resistance of the pile. Comparing field and laboratory tests indicates that the behavior of pile groups predicted by the analysis is in qualitative agreement with observed behavior. (USBR)

W71-03740

#### THE SAFETY FACTOR IN EXCAVATIONS AND FOUNDATIONS,

Law Engineering Testing Co., Atlanta, Ga.  
G. F. Sowers.

Highway Research Record No 269, p 23-34, 1969.  
12 p, 3 fig, 1 tab, 2 ref.

Descriptors: \*Foundations, \*Excavation, Failures, Safety factors, Soil mechanics, Statistical analysis, Safety, Loads (Forces), Soil properties.

Identifiers: Empirical methods.

The safety design and safety factor in excavations and foundations are discussed. The resistance to failures is provided by an assemblage or system of structural components. Three approaches are described: (1) statistical analysis, (2) the component approach, and (3) the empirical approach. A statistical analysis becomes unreliable at the extremely low probabilities that must be considered in design. The component approach uses varying safety factors to be applied to the loads acting on the structure as well as to the various soil properties used in analysis. Safety factors are also applied to the components of soil strength individually. This approach is judged sound, but additional components of the safety factor are necessary because of the uncertainties in the accuracy of the engineering analysis used. The empirical approach is that of an overall safety factor developed from experience. Proper use of the empirical approach requires that there be a full study of all failures that occur so that the source of error can be pinpointed and the uncertainties involved in loading, evaluation of resistances, and engineering analysis can be established. (USBR)

W71-03741

#### GEOTECHNICAL CONSIDERATIONS OF LATERAL STRESSES,

Cornell Univ., Ithaca, N.Y.

D. J. Henkel.

1970 Special Conference on Lateral Stresses  
Ground Design Earth-Retaining Structures, Cornell Univ., Ithaca, N.Y., p 1-49, June 1970. 49 p, 19 fig, 32 ref, append.

Descriptors: \*Earth pressure, Soil mechanics, Stress, Swelling, Active pressures, Passive pressures, \*Consolidation, Bibliographies, Pore water pressures, \*Overconsolidation, \*Clays, Excavation, Rebound, \*Effective stress, \*Stress-strain curves, Strain.

Identifiers: Geotechnics, Stress paths, Plane strain.

In situations involving earth pressures, the consideration of a somewhat simplified stress system is useful to enable the interrelation between the active and passive stresses to be seen and to provide a rational basis for the use of engineering judgment on how the particular excavation will behave. The emphasis of this paper is on understanding the behavior of clay soils in normally consolidated and over consolidated conditions. Changes in stability associated with the dissipation of excess pore water pressures set up during construction are discussed. In some cases, the original deposits of normally consolidated clays have been uplifted and subjected to the processes of erosion which have removed many hundred or even thousands of feet

of the overlying sediments. Vertical effective stresses have been reduced, swelling in the vertical direction has taken place, and lateral stresses have changed. Heavily overconsolidated clays may be at or near a state of passive failure at shallow depths. Shear zones, in which the strength is lower than in the intact clay, may have been created. The existence of these shear zones may be important in lateral stress problems. Has 32 references. (USBR)

W71-03747

#### BRACED EXCAVATIONS,

Massachusetts Inst. of Tech., Cambridge.  
T. W. Lambe, and E. K. Turner.

1970 Special Conference on Lateral Stresses  
Ground Design Earth-Retaining Structures, Cornell Univ., Ithaca, N.Y., p 149-218, June 1970. 70 p, 43 fig, 1 tab, 27 ref, append.

Descriptors: Bracings, Excavation, \*Analytical techniques, Field data, Reviews, Soil mechanics, Design, \*Lateral forces, \*Earth pressure, Earth movements, Soil pressure, Pore water pressures, Stress, Trenches, \*Cuts, Strain Loads (Forces), Supports, Bibliographies, \*Retaining walls, Load distribution, Settlement (Structural), Movement, Performance.

Identifiers: Design practices.

This review of the state-of-the-art of braced excavations includes: (1) an overview of the excavation problem and factors that influence the behavior of an excavation; (2) several key fundamentals that are widely misunderstood or ignored; (3) predictions of performance of 3 excavations by several analytical techniques, and comparisons of measured field performance to the predictions; and (4) a proposed step-by-step approach to the engineering of a braced excavation. Various methods of analysis are discussed and evaluated. Field measurements and analysis of the 3 excavations showed that: (1) pore pressures were far below static values; (2) steady-state seepage analysis gave reasonable predictions of pore water pressures; (3) bracing strut loads varied widely; (4) significant movements occurred below the bottom of the excavations; (5) much smaller movements occurred behind the reinforced concrete wall than behind the sheet pile walls; (6) significant settlements occurred far back from the excavation; and (7) a significant portion of the settlement can be attributed to consolidation settlement. The general conclusion is that strut loads and movements of soil outside an open excavation cannot be predicted with confidence using present methods of analysis. (USBR)

W71-03748

#### DESIGN OF EARTH RETAINING STRUCTURES FOR DYNAMIC LOADS,

California Univ., Berkeley, and Massachusetts Inst. of Tech., Cambridge.  
H. B. Seed, and R. V. Whitman.

1970 Special Conference on Lateral Stresses  
Ground Design Earth-Retaining Structures, Cornell Univ., Ithaca, N.Y., p 103-147, June 1970. 45 p, 32 fig, 5 tab, 31 ref.

Descriptors: Earthquakes, \*Retaining walls, Design, Model tests, Water pressure, Design criteria, Soil mechanics, \*Lateral forces, Blasts, Soil pressure, Explosions, Failure (Mechanics), Analytical techniques, Safety factors, Bibliographies, Live loads, Reviews.

Identifiers: Earthquake damage, \*Dynamic loads, Dynamic tests, Seismic stability, Design practices, Recommendations, \*Earthquake loads.

A review of the state of knowledge concerning the design of earth-retaining structures for increased lateral pressures caused by earthquakes, explosions, or blasts is presented. The general practice in the U.S. and many other countries is to make no special allowance for dynamic loads caused by earthquakes. Several failures are cited to show that increased lateral pressure must be considered a significant design problem in seismic regions.

Methods for determining dynamic lateral pressures on retaining structures above and below the water table are reviewed, and recommendations for earthquake-resistant design are presented. The design of structures for protection against explosions and the maximum accelerations allowed to avoid damage to retaining walls and freshly placed concrete from nearby blasting are discussed. (USBR)

W71-03749

#### ABOUT THE SAFETY FROM SUBSURFACE EROSION OF EARTH DAMS SUBJECT TO UNDERSEEPAGE,

Technische Hochschule, Darmstadt (West Germany).

H. Breth, and K. Gunther.

10th International Congress on Large Dams, Montreal, Can., Vol 2, Quest No 37, p 431-451, June 1970. 21 p, 9 fig, 24 ref.

Descriptors: Seepage, \*Underseepage, Safety, Dams, \*Earth dams, Dam design, Uplift pressure, Dam foundations, Pervious soils, Subsurface flow, Soil mechanics, Blowouts, Analytical techniques, Sand boils, Heaving, Percolation, Foreign research, Foundation failure, Bibliographies.

Identifiers: Seepage control, Design practices, \*Piping (Erosion), German Federal Republic.

The potential theory method and Lane's method of assessing the safety from subsurface erosion of dams subjected to underseepage are compared, and the practicability and limits of applicability are investigated. Lane's method can lead to dangerously inaccurate estimates of the safety of dams founded on stratified subsoil and to extremely uneconomical designs, especially when a large head difference exists between the upstream and downstream sides of the dam and when filter layers or drainage systems are provided. The potential theory method in some cases gives criteria causing difficulties and uncertainties in estimating safety from erosion, but experience shows that the method leads to economical designs safe from subsurface erosion when applied with care. Lane's method should be used only for small dams founded on largely homogeneous soils; the potential theory method should be used for all other cases. (USBR)

W71-03750

#### NEW TECHNIQUE OF SLUICING SCREENED STONES WITH SAND AND LOAM AS PERFORMED IN THE HIGH ASWAN DAM,

Aswan High Dam (United Arab Republic). Technical Research Dept.

M. E. Hassouna, W. K. Shenouda, and K. Nashed.  
10th International Congress on Large Dams, Montreal, Can., Vol 2, Quest No 37, p 777-792, June 1970. 16 p, 9 fig.

Descriptors: Construction, \*Rock fills, \*Rockfill dams, Voids, Earth dams, Testing, Foreign construction, Underwater construction, Quality control, Cofferdams, Screening, Hydraulic transportation, \*Hydraulic fills, Dam construction, Gradiation, River closures.

Identifiers: Aswan Dam, UAR (United Arab Republic), Construction control, Construction methods, \*Sluicing.

Sluicing with sand, delivered in the form of a hydraulic pulp, to fill the voids of rockfill in the High Aswan Dam in the United Arab Republic is described. Sluicing was successful above and below water and was performed to: (1) decrease seepage through the dam, (2) avoid piping, and (3) eliminate the need for constructing an inverted filter in deep flowing water. Studies to furnish data about the nature of sluicing, factors affecting the process, methods of delivery of sand, optimum gradation of rockfill, and efficiency of the sluicing method are discussed. Construction control procedures are described. Screening of the rockfill materials to be sluiced was necessary for successful void filling. (USBR)

W71-03751

## Field 08—ENGINEERING WORKS

### Group 8D—Soil Mechanics

#### FILLING AND COMPACTION OF SAND BY DEEP VIBRATORS AND VIBROROLLERS IN THE HIGH ASWAN DAM,

High Aswan Dam (United Arab Republic). Technical Research Dept.

M. E. Hassouna, and W. K. Shenouda.

10th International Congress on Large Dams, Montreal, Can., Vol 5, Gen Rep, p 411-432, June 1970. 22 p, 12 fig.

Descriptors: \*Earth dams, \*Compaction, Compaction equipment, Dune sands, Compaction tests, \*Hydraulic-fill dams, Hydraulic fills, Density, Penetration resistance, Penetration tests, Penetrometers, Field tests, Dam construction, Foreign construction, Dam design, Quality control, Hydraulic transportation, Soil compaction.

Identifiers: \*Vibratory compaction, United Arab Republic, Aswan Dam, UAR, Permeability tests, Construction methods.

In constructing the High Aswan Dam in the United Arab Republic, a technique of hydraulically placing dune sand on both sides of a clay core and compacting it with deep vibrators or vibrorollers was used successfully and economically. The first part of the fill was placed under water at a depth of up to 35 m in 2 layers each 14-15 m thick. The underwater part of the fill was compacted, using deep vibrators working from floating rigs, to a depth of 15 m under a water depth of up to 19 m. Deep vibrators and methods used to compact 3,400,000 cu m of dune-sandfill in a 4-mo period are described. That part of the fill above the water surface was hydraulically placed in layers 1.5-2.0 m thick and compacted with vibrorollers. Methods of measuring compaction in the underwater zone and the dry zone of the dam are discussed. (USBR) W71-03752

#### FOUNDATION INSTRUMENTATION AT PLEASANT VALLEY PUMPING PLANT,

Bureau of Reclamation, Denver, Colo. Office of Chief Engineer.

William H. Roth.

Available from NTIS as PB-195 272, \$3.00 in paper copy, \$0.95 in microfiche. Bureau of Reclamation Report REC-OCE-70-23, June 1970. 32 p, 24 fig, 2 tab, 1 ref.

Descriptors: Instrumentation, \*Foundations, Stress concentration, Pore pressure, Stress distribution, \*Earth pressure, \*Uplift pressure, Walls, Pore water pressures, Flow nets, Structural stability, Performance, Land subsidence, Stability analysis, Field data, \*Piezometers, \*Drains, \*Soil pressure, Lateral forces, Settlement (Structural), Safety factors, California.

Identifiers: Pleasant Valley Pumping Plant (Calif), Stress gages, Deep subsidence, \*Stress meters.

Stress meters and piezometers were installed at Pleasant Valley pumping plant in California to record soil and pore pressures underneath and along the back wall of the structure and to monitor functioning of a drain that was constructed along the base of the back wall to reduce uplift pressure under the structure and horizontal pressure on the wall. Included in the report are: (1) a discussion of conditions prompting the drain and instrumentation installation; (2) drawings showing features of the pumping plant and pumping plant excavation; (3) drawings showing locations and details of installation of the stress meters and piezometers; (4) logs of drill holes showing foundation conditions; (5) a description and drawings showing results of an electrical analogy tray study to determine the flow net for the high cut slope adjacent to the pumping plant; (6) a discussion and drawings showing results of stability studies made for the structure; (7) plots showing stress meter and piezometer reading through Feb 2 and Feb 12, 1970, respectively; (8) plots of wall pressures determined from the stress meter readings; and (9) a discussion of unexpected stress meter and piezometer readings and possible explanations. (USBR) W71-03767

### 8E. Rock Mechanics and Geology

#### HEAD LOSSES IN UNLINED ROCK TUNNELS,

Royal Inst. of Tech., Stockholm (Sweden).

For primary bibliographic entry see Field 08B. W71-03735

#### ENGINEERING AND ROCK MECHANICS,

C. Jaeger.

Water Power, Vol 22, No 5/6, 7/8, p 203-209, 253-259, May/June, July/Aug 1970. 14 p, 25 fig, 3 tab, 58 ref.

Descriptors: \*Rock mechanics, Rock foundations, Rock properties, Dams, \*Rockslides, \*Concrete dams, \*Dam foundations, \*Dam failure, Dam design, Engineering geology, Engineering, Uplift pressure, Hydrostatic pressure, Grout curtains, Laboratory tests, Analytical techniques, Bibliographies, Fractures (Geology), Strength, Slope stability, Safety.

Identifiers: Rockfalls, \*Rock slope stability, Rock tests, Malpasset Dam, France, In situ tests, Vajont Slide, Italy, Dam stability.

Rock conditions, methods used for testing rock, and choice of solutions of problems for several concrete dams are described to show to what extent known methods of rock mechanics can be used in solving engineering problems and to what extent present knowledge of rock properties is lacking and insufficient for clear technical decisions. Some proposed changes in the treatment of foundations for concrete dams, methods of analysis of galleries and excavations in rock, rock slope stability, and several major rockslides are discussed. Analysis of conditions leading to the Malpasset Dam failure in France and to the Vajont rockslide in Italy are given special attention. Has 58 references. (USBR) W71-03736

### 8F. Concrete

#### CONCRETE BEAMS WITH PRESTRESSED REINFORCEMENT,

Ohio State Univ., Columbus.

A. Bishara, and F. N. Almeida.

Proc Amer Soc Civ Eng, J Struct Div, Vol 96, No ST7, p 1445-1460, July 1970. 16 p, 5 fig, 4 tab, 10 ref, 2 append.

Descriptors: \*Beams (Structural), \*Reinforced concrete, Reinforcement, Prestressed concrete, Precast concrete, Cracking, Deflection, Moments, Structural behavior, Structural members, Analytical techniques, Strain, Elasticity modulus, Laboratory tests, Structural engineering.

Identifiers: Reinforcing materials, Composite systems, \*Composite beams, Strain hardening, Ultimate strength.

Test on 6 rectangular beams reinforced with variable amounts of deformed steel bars and precast prestressed concrete prisms are reported. Methods are suggested for computing the moment causing cracking of in situ concrete and that causing cracking of prestressed reinforcement. After cracking of prestressed reinforcement, and up to the beginning of yield of nonprestressed tension reinforcement, flexural analysis can be done using assumptions of classic working stress design by associating to the combined area of strand and deformed bars a pseudo-modulus of elasticity higher than that of ordinary steel. During this stage for similar beams having equal total areas of tension reinforcement, the ratio between their maximum crack widths was practically equal to the inverse of their respective pseudo-moduli. Strain hardening effects should be taken into consideration in estimating ultimate moment capacity of beams reinforced with such composite reinforcement. (USBR) W71-03354

#### CONCRETE-POLYMER DEVELOPMENT,

Brookhaven National Lab., Upton, N.Y.

M. Steinberg.

Nuclear News, Vol 13, No 9, p 48-54, Sept 1970. 7 p, 4 fig, 4 tab, 3 ref.

Descriptors: \*Concrete technology, Concrete mixes, Radiation, Concrete testing, \*Concretes, Composite materials, Impregnation, Monomers, Costs, Materials, Materials engineering, \*Polymers, Research and development, Chemical properties, Physical properties, Durability, \*Construction materials, Strength, Mechanical properties.

Identifiers: \*Polymerization, \*Concrete-polymer materials, \*Concrete properties, \*Polymer concretes.

Findings of a cooperative research program underway to investigate and develop concrete-polymer composites as new construction materials are presented. Methods of impregnating precast concrete with monomers, selection of monomers, polymerization techniques, and premixing monomers with concrete before curing are discussed, and the following data are presented: (1) properties of concrete with and without polymer; (2) effects of temperature and polymer content on the compressive strength of concrete; (3) properties of lightweight concrete containing polymer; (4) a comparison of properties and costs of concrete-polymer materials to basic construction materials; and (5) composition and compressive strength of several concrete-polymer materials and polymer-concrete composites. Concrete impregnated with methyl-methacrylate shows impressive improvements in strength, durability, and watertightness. Based on preliminary estimates, the cost of concrete-polymer sewer pipe produced by radiation treatment is about double the cost of ordinary concrete pipe containing the same volume of concrete. Use of concrete-polymer material for structural purposes appears economically feasible because considerable less volume of concrete polymer is required to produce strengths equal to ordinary concrete. (USBR) W71-03734

#### THE PROPERTIES OF AN EPOXY MORTAR AND ITS USE FOR STRUCTURAL JOINTS,

Selwyn Coll., Cambridge (England).

R. P. Johnson.

Structural Engineering, Vol 48, No 6, p 227-233, June 1970. 7 p, 8 fig, 2 tab, 10 ref, append.

Descriptors: \*Concrete technology, \*Epoxy resins, Compression, Foreign research, Structural design, \*Joints (Connections), Mortar, Creep, Shear strength, Aggregates, Compressive strength, Elasticity modulus, Testing, Stress-strain curves, Shrinkage, Adhesives, Test specimens, Precast concrete.

Identifiers: \*Epoxy mortar, Creep tests, Great Britain, Test results, Foreign testing, Fatigue tests.

Formulation of an epoxy mortar intended for use in structural joints is discussed with relation to recent work on mix design. Results of extensive tests on creep and ultimate strength show that the epoxy mortar is suitable for use in structural joints in precast concrete that transmit combined shear and compression, and that its flexibility and creep are little greater than that of concrete. Resin mortar mixes are discussed, with particular emphasis on Mix M used in the tests described. Conclusions are that concrete structures containing joints made with an epoxy mortar similar to that tested may be designed as if they were monolithic. (USBR) W71-03738

#### PRESTRESSED CONCRETE LINING OF A ROCKFILL DAM,

Research Inst. for Civil Engineering, Bratislava (Czechoslovakia).

L. Hobst.

Tenth International Congress on Large Dams, Montreal, Can., Vol 1, Quest No 36, p 207-213, June 1970. 7 p, 4 fig.

#### MATERIALS

## Materials—Group 8G

Descriptors: \*Dams, \*Rockfill dams, Impervious linings, Prestressing, Concretes, Deformation, \*Prestressed concrete, Flexibility, Cutoff walls, Construction.  
Identifiers: \*Dam facings.

Prestressing the concrete facing on the upstream side of a rockfill dam increases the flexibility of the facing and its adaptability to deformations of the dam. Construction of the prestressed concrete facing on a rockfill dam at Skalka, Czechoslovakia, is described. The lining was prestressed in one direction only—parallel with the slope—using cables manufactured of spliced steel ropes and a prestressing force of 70 MPa. The spacing of cables permitted placing the concrete facing by a machine moving along the slope of the upstream face of the dam. Control measurements proved that the desired prestressing was attained. Construction of the lining with prestressed concrete proved to be very satisfactory. (USBR)  
W71-03744

#### CONCRETE MASONRY STRUCTURES—DESIGN AND CONSTRUCTION.

American Concrete Inst. Detroit, Mich. Committee 531.

J Amer Concr Inst, Proc Vol 67, No 5, 6, p 380-403, 442-460, May, June 1970. 43 p, 6 fig, 7 tab, 2 append.

Descriptors: \*Masonry, \*Structural design, \*Specifications, Design, Admixtures, Construction, Testing, Anchors, Backfill, Deflection, Beams (Structural), Cold weather construction, Columns, Compressive strength, Structures, Foundations, Reinforcing steel, Grouting, Loads (Forces), Mortar, Shear stress, Wind pressure, Thermal expansion.

Identifiers: \*Concrete blocks, Control joints, Bond strength, Bond, Earthquake-resistance struct, Anchor bolts.

Recommendations are provided for the design and construction of reinforced and nonreinforced concrete masonry structures using units manufactured to ASTM specifications. The manufacturing process is not discussed, and mortarsless masonry and construction using resin-type adhesives between the units are not covered. Design recommendations based on the working stress method give allowable stresses for reinforced and nonreinforced masonry. Construction recommendations include chapters on materials and specifications, mortar and grout, preferred construction practices, determination of masonry strength, inspection, connections to embedded and adjoining construction, and reinforcing bar details. Design chapters deal separately with reinforced walls and columns and nonreinforced walls and columns. Shear, bond, and anchorage provisions are given for reinforced masonry. Recommendations for control of wall movements are made, and construction of masonry veneers, screen walls, and fences is described. Approximately 200 terms relating to masonry design and construction appear in the appendix. (USBR)  
W71-03754

#### EFFECT OF SPECIMEN SIZE ON TENSILE STRENGTH OF CONCRETE,

Department of Energy, Mines and Resources, Ottawa (Ontario).  
V. M. Malhotra.

J Amer Concr Inst, Proc Vol 67, No 6, p 467-469, June 1970. 3 p, 3 fig, 3 ref.

Descriptors: \*Concrete technology, Concrete mixes, Concretes, Research and development, \*Test specimens, \*Concrete testing, Water-cement ratio, Splitting tensile strength, \*Tensile strength, Test procedures, Foreign research, Statistical analysis, Size, Effects.  
Identifiers: Test results, Canada, \*Tension tests, Foreign testing.

Results of an investigation to determine the effect of specimen size on tensile strength of concrete are

presented. Direct-tension, ring-tension, and splitting-tension tests were used during the investigation. Twenty-one concrete mixes were prepared, and 6- and 12-in.-dia rings and 4- by 8-in. and 6- by 12-in. cylinders were cast and tested. Analysis of test results from 276 specimens showed that irrespective of the test method used, tensile strength values decreased with increase in size of the specimens. The average decrease in strength varied from about 14% in the ring-tension test to about 7% in the direct-tension and splitting-tension tests. (USBR)  
W71-03755

#### DEVELOPMENT OF A STRESS RELIEF METHOD WITH A THREE-DIRECTIONAL BOREHOLE DEFORMATOMETER GAGE,

Bureau of Reclamation, Denver, Colo. Engineering and Research Center.  
W. G. Austin.

Bureau of Reclamation Report REC-OCE-70-10, Mar 1970. 74 p, 51 fig, 17 tab, 5 ref, append.

Descriptors: Concrete testing, Laboratory tests, Cores, Mass concrete, Elasticity modulus, \*Internal forces, \*Stress relieving, Deformation, Rock mechanics, Three-dimensional, \*Drill holes, \*Strain measurement, Core drilling, Boreholes, Research and development, Test procedures, Testing, \*Stress, Strain, Analytical techniques, Orientation.

Identifiers: In situ tests, Rock tests, \*Borehole deformation gage, \*Overcoring method, Testing equipment, \*Internal stress.

Laboratory tests and analysis were performed to develop testing techniques and to check a method for determining in situ stress in an isotropic elastic body described in a Bureau of Mines report. The method is based on measuring the diametrical change in a borehole caused by overcoring with a larger-diameter bit, and indicates that measurements in 2 nonparallel, nonperpendicular drill holes are sufficient to determine all 6 components of 3-dimensional stress. Necessary equipment was fabricated, calculations for the 2-drill hole approach were programmed for computer analysis, and stress relief tests were performed on 3 biaxially loaded concrete blocks. Test results were analyzed, but solutions were unobtainable. Further study indicated that 3 drill holes are required to obtain solutions. A computer program was prepared for determining stresses for 3 or more drill holes, additional stress relief tests were performed using 3 drill holes, and satisfactory solutions were obtained. Conclusions are: (1) 3 nonparallel drill holes are required to obtain a 3-dimensional stress solution; (2) the stress-relief method using the borehole gage requires complex and precise procedures; and (3) the method is suitable for obtaining stresses in large masses. (USBR)  
W71-03757

#### CEMENTING WATER WELLS,

Halliburton Oil Well Cement Co., Houston, Tex.  
For primary bibliographic entry see Field 08A.  
W71-03848

## 8G. Materials

#### THE APPLICATION OF BITUMEN FOR EARTH AND ROCKFILL DAMS,

Shell International Petroleum Co. Ltd., London (England); and Shell A. G., Hamburg (West Germany).  
For primary bibliographic entry see Field 08D.  
W71-03350

#### SOME LOADING TEST ON LONG PIPE PILES,

Golder, Brawner and Associates Ltd., Vancouver (British Columbia).  
For primary bibliographic entry see Field 08D.  
W71-03360

THE DYNAMIC PENETRATION TEST: A STANDARD THAT IS NOT STANDARDIZED, Illinois Univ., Urbana; La Plata Univ. (Argentina); and Sao Paulo Univ. (Brazil).  
For primary bibliographic entry see Field 08D.  
W71-03361

#### AN INVESTIGATION OF A CONE-PENETROMETER METHOD FOR THE DETERMINATION OF THE LIQUID LIMIT,

Road Research Lab., Crowthorne (England).  
For primary bibliographic entry see Field 08D.  
W71-03362

#### PREVENTING FILAMENTOUS SCALE IN WATER WELLS,

Sayreville Water Works, N.J.  
Andrew Piatek.

Water and Wastes Engineering, Vol 4, No 12, p 54-55, December 1967. 9 ref.

Descriptors: \*Water wells, \*Corrosion, \*Iron removal, Well maintenance, Crenothrix, Scale, Colloidal clay.

Identifiers: \*Water well chemical treatment, Gallionella sp., Beggiatoa sp., Leptothrix sp., Chlorine dioxide treatment, Calcium hypochlorite, Well surging, Well cleaning, Line cleaning.

Systems of chemical treatment for preventing formation of filamentous scale in well water containing iron bacteria and colloidal clay are reviewed. Laboratory experiments indicate that chlorine dioxide has ability to destroy iron bacteria. The water from wells in the Sayreville, New Jersey area was higher in colloidal clay at certain times than at others. It was assumed that the problem was complicated by iron bacteria using clay as a nucleus to aggregate with other insoluble salts in the formation and by rapid growth of the heavy muck in the system. The treatment was divided into two parts: (1) well surging and cleaning, and (2) line cleaning. The system of treatment has been successful for a year. It also appears that corrosion is being held at a lower level. (Campbell-NWWA)  
W71-03835

#### PERFORMANCE OF ALLOYS AGAINST EROSION - CORROSION ATTACK,

Stainless Foundry and Engineering, Inc., Milwaukee, Wis.

G. Schiebelbein.  
Materials Protection, Vol 9, No 6, p 11-13, June 1970. 4 fig, 6 tab, 1 ref.

Descriptors: \*Pumps, \*Corrosion, Pitting (Corrosion), Chemical degradation.

Identifiers: \*Alloy performance, \*Erosion-corrosion measurements, Illium PD, Illium 98, CN-7M (Alloy 20), Sulfite processing, Pump repair, Pulp and paper industry, Impeller failure.

The high frequency of pump repair and replacement in the pulp and paper industry prompted a research program to develop an alloy that would resist the attack of abrasive slurries in corrosive media. The comparative performance of alloys commonly used in paper mills is described. According to field test results, Illium PD extended pump life to nearly two years, compared with five months obtained from the commonly used modified CN-7M alloy. (Campbell-NWWA)  
W71-03838

#### SECOND CORROSION STUDY OF PIPE EXPOSED TO DOMESTIC WATERS,

G. B. Hatch, J. F. J. Thomas, and R. W. Lane.  
Materials Protection, Vol 9, No 6, p 34-37, June 1970. 3 fig, 3 ref.

Descriptors: \*Water wells, \*Corrosion, Pitting (Corrosion), Aluminum, Chemical degradation, Water supply.

Identifiers: Domestic water, Pipe exposure study, Galvanized steel, Galvanized wrought iron pipe, Alclad, Water type, Flow velocities, Test installations, Cold water, Copper, Chloride, pH, CaCO<sub>3</sub>.

## Field 08—ENGINEERING WORKS

### Group 8G—Materials

An earlier pipe exposure study to establish the corrosivity of several public water supplies to metal ordinarily used for domestic and institutional service pipe demonstrated the need for further study of the factors of quantity and velocity of water flow. Galvanized steel and galvanized wrought iron-pipe were tested under varied controlled and metered flow conditions at cold water temperature for the same 24 hour period as in the earlier study. Alclad and aluminum specimens were also tested. This report concerns the investigation of corrosion by 25 selected types of domestic waters only, with no attempt to cover all domestic waters. The following conclusions were made: (1) specimen types were equal in corrosion resistance to cold water, (2) copper and chloride are the predominant factors causing increased corrosion of the galvanized metals, (3) major problems of this study was experiment duration. Extended durations needed, (4) total flow and velocity factors did not reveal much additional information. However, specimens exposed to intermittent and lower flow rates were more severely corroded, (5) In the case of Alclad and aluminum, dissolved oxygen, copper and chloride were factors which appeared responsible for increased corrosion, except at higher velocities, (6) completely softened (zeolite treated) water, increased corrosion of all metals tested, (7) silicate treatment (8ppmSiO<sub>2</sub>) of high chloride-sulfate water was successful for inhibition. (Campbell-NWWA)  
W71-03839

## 8I. Fisheries Engineering

**INDIA EYES THE OCEAN'S RESOURCES,**  
Science Service, Washington, D.C.  
For primary bibliographic entry see Field 06E.  
W71-03599

**MARINE AQUACULTURE,**  
National Science Foundation, Washington, D.C.  
Office of Science Information Service.  
For primary bibliographic entry see Field 02L.  
W71-03772

## 09. MANPOWER, GRANTS AND FACILITIES

### 9A. Education (Extramural)

**MANPOWER SUPPLY IN WASTE WATER TREATMENT PLANTS,**  
Purdue Univ., Lafayette, Ind. Water Resources Research Inst.  
For primary bibliographic entry see Field 05D.  
W71-03521

### 9C. Research Facilities

### A WATER RESOURCES ECOLOGY CAPABILITY FOR THE WATERWAYS EXPERIMENT STATION AND CORPS OF ENGINEERS, Army Engineer Waterways Experiment Station, Vicksburg, Miss.

J. Cairns, and P. S. Humphrey.

Sponsored by Assistant Secretary of the Army (R and D), Department of the Army. U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Contract Report 0-69-1, May 1969. 26 p.

Descriptors: \*Ecology, \*Research facilities, \*Ecosystems.

Reports Waterways Experiment Station capability for filling the existing need for a government agency which can study drainage basins, estuaries, shorelines and bays from the ecological systems viewpoint and provide regional planners with the ecological information which will enable them to plan wisely for the optimization of the resource from the multiple use standpoint. Defines areas of ecological programs. Shows relation of WES ecology capability to planning and implementation of civil projects. Recommends establishment at WES of a water resources ecology study group, formation of a Water Resources Ecology Advisory Board, and selection of a pilot project. (Spivey-WES)  
W71-03318

## 10. SCIENTIFIC AND TECHNICAL INFORMATION

### A STUDY OF WATER RESOURCES INFORMATION SERVICES, Texas A and M Univ., College Station. Coll. of Business Administration. Eugene B. Smith.

Water Resources Bulletin, Vol 6, No 6, p 907-919, November-December 1970. 13 p, 7 fig, 2 ref. OWRR Project W-103 (No 1609) (5).

Descriptors: \*Abstracts, \*Information retrieval, \*Evaluation, Documentation, Publications, Libraries, Reviews, Surveys.

Identifiers: \*Information services.

A study was designed to analyze two types of information services provided by the Water Resources Scientific Information Center (WRSIC). This study was conducted to assess the monetary value and acceptability to users of the Selected Water Resources Abstracts (SWRA) Journal and the Selective Dissemination of Information (SDI) System. Both services were well received and provide a useful and valuable service to a variety of users active in the area of water resources. Major

limiting factors associated with the conduct of the study were those involving limited user experience with the services and the absence of a capability to group the participants according to various parameters. The SDI service was discontinued during August, 1969 because of budgetary limitations. The results of this study indicate that consideration should be given to resumption of this service when funding permits. Additional consideration should be given to the problem of document acquisition by the user. (Knapp-USGS)  
W71-03317

### BIBLIOGRAPHY: SCIENTIFIC FUNDAMENTALS OF THE EUTROPHICATION OF LAKES AND FLOWING WATERS, WITH PARTICULAR REFERENCE TO NITROGEN AND PHOSPHORUS AS FACTORS IN EUTROPHICATION,

Organization for Economic Co-Operation and Development, Paris (France).

Richard A. Vollenwider.

Organization for Economic Co-Operation and Development, Ex 40108, 1970. 61 p, 716 ref.

Descriptors: \*Bibliographies, \*Eutrophication, \*Phosphorus, \*Nitrogen, Lakes, Rivers, Impoundments, Aquatic life, Plankton, Biomass, Productivity, Trophic level, Nutrients, Water pollution control, Water pollution effects, Water pollution sources, Waste water treatment, Inorganic compounds.

Identifiers: \*OECD, \*Committee for Research Cooperation, Aquatic blooms, Hydrophytes, Nutrient sources, Nutrient concentrations.

This bibliography contains 716 references pertaining to the problems of eutrophication of inland waters. It is a supplement to paper OECD No 40105, titled 'Scientific fundamentals of the eutrophication of lakes and flowing waters, with particular reference to nitrogen and phosphorus as factors in eutrophication.' (See W71-03447) issued by the Organization for Economic Cooperation and Development (Paris) and is published as a separate paper. (Auen-Wisconsin)  
W71-03448

### DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT VOLUME I TEST-CASE STUDIES,

Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

For primary bibliographic entry see Field 05A.  
W71-03770

### DESIGN OF AN OVERVIEW SYSTEM FOR EVALUATING THE PUBLIC-HEALTH HAZARDS OF CHEMICALS IN THE ENVIRONMENT, VOLUME II. THE OVERVIEW SYSTEM,

Battelle Memorial Inst., Columbus, Ohio. Columbus Labs.

For primary bibliographic entry see Field 05A.  
W71-03771

### NATURAL RESOURCES IN THE GOVERNMENTAL PROCESS A BIBLIOGRAPHY SELECTED AND ANNOTATED,

Arizona Univ., Tucson. Inst. of Government Research.

For primary bibliographic entry see Field 06E.  
W71-03804

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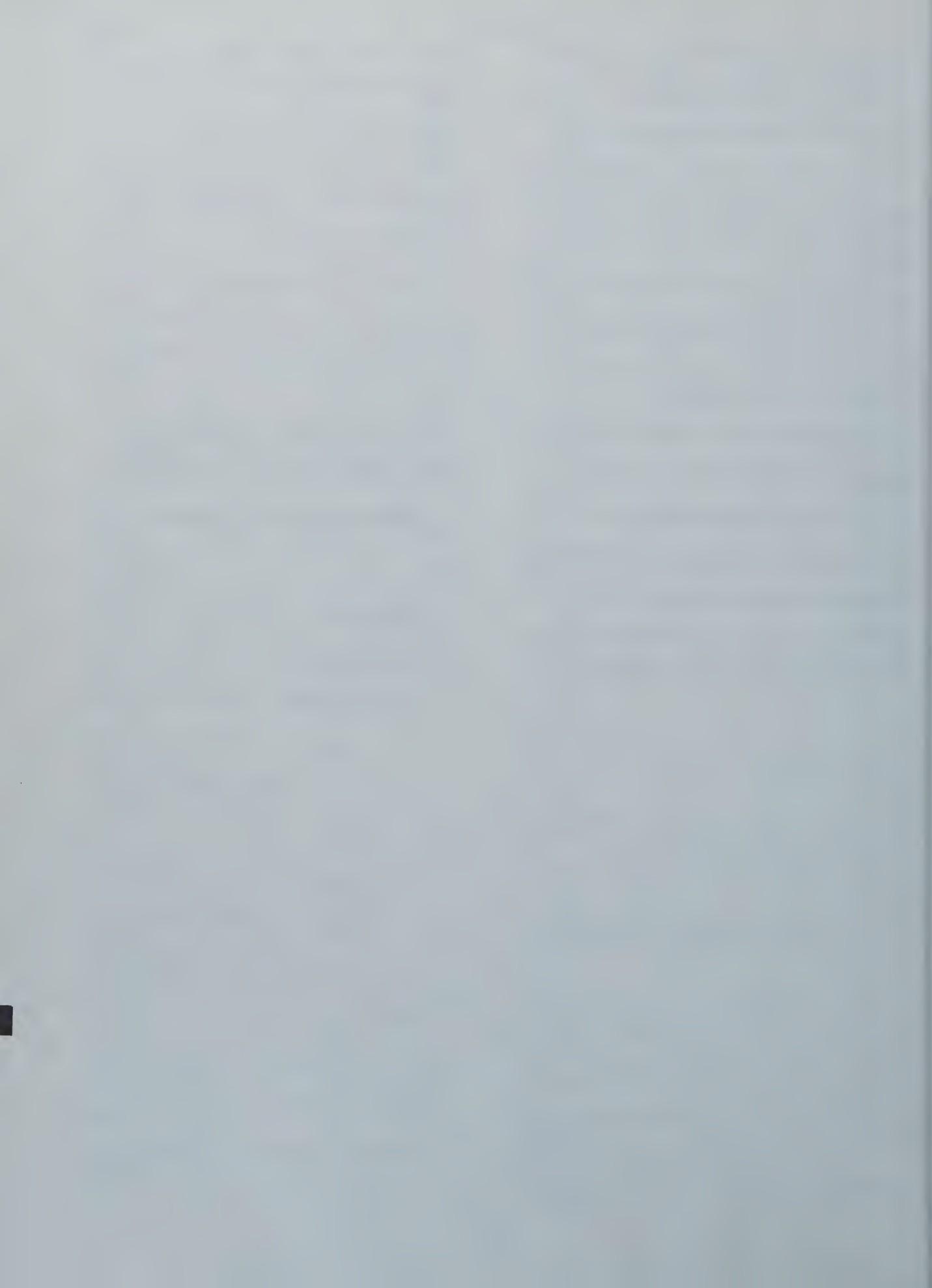
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## CENTERS OF COMPETENCE AND THEIR SUBJECT COVERAGE

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.
- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin, jointly sponsored by the EPA, Soap and Detergent Association, and the Agricultural Research Service.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.
- Water well construction technology at the National Water Well Association.

Supported by the Environmental Protection Agency in cooperation with WRSIC.

- Thermal pollution at the Department of Sanitary and Water Resources Engineering of Vanderbilt University.
- Textile wastes pollution at the School of Textiles of North Carolina State University.
- Water quality requirements for freshwater and marine organisms at the College of Fisheries of the University of Washington.
- Wastewater treatment and management at the Center for Research in Water Resources of the University of Texas.
- Agricultural livestock wastes at the Department of Agricultural Engineering of Iowa State University.

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